

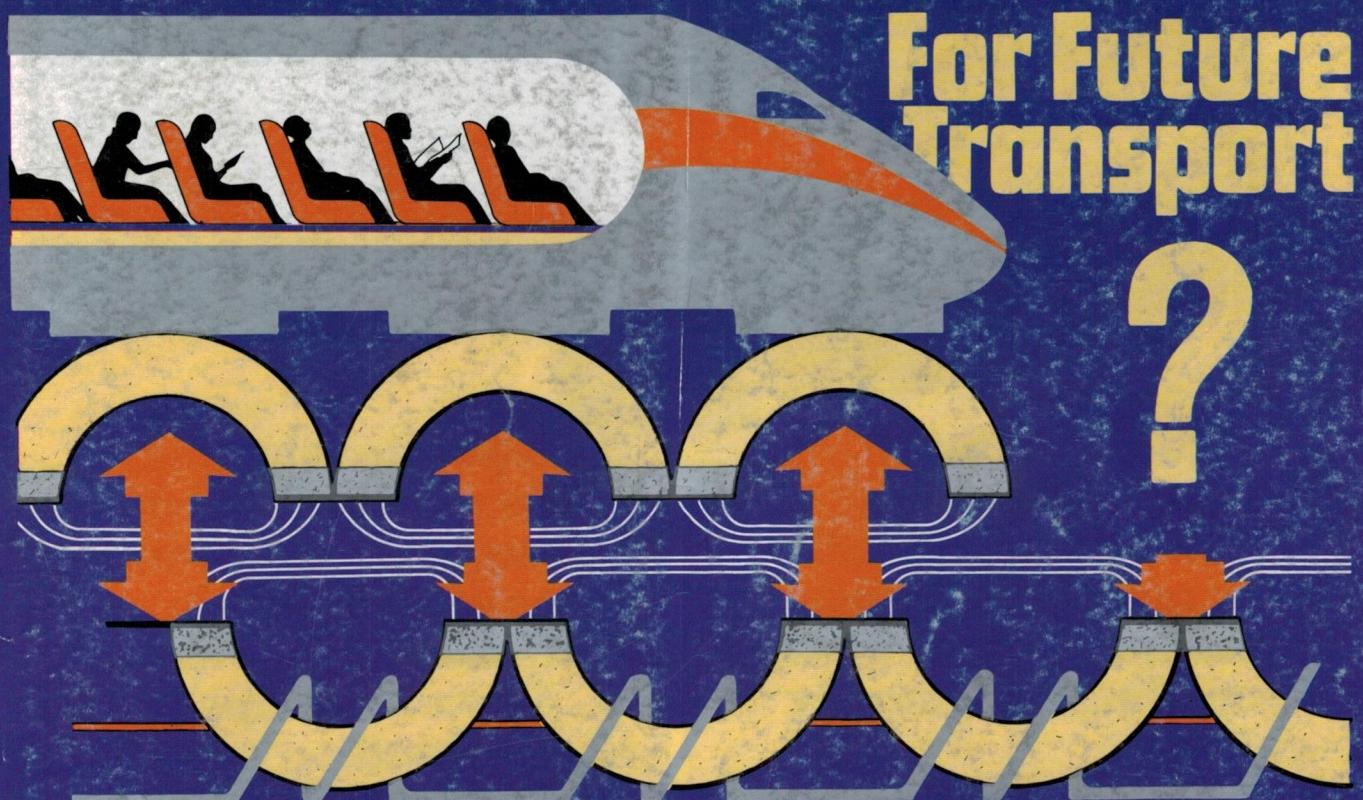
NOV. 1981 \$1.95\* NZ \$2.50



ELECTRONICS  
TODAY  
INTERNATIONAL

# MAGNETIC LEVITATION

For Future  
Transport



Completing the  
**660 LEARNERS'**  
**MICROCOMPUTER**

**Handheld Printer**  
**'Low Ohms' Meter to build**

**CARVER**  
**Magnetic**  
**Field**  
**Amplifier**  
**Reviewed**

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MX0035/FMMH



# ELECTRONICS TODAY INTERNATIONAL

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ISSN No. 0013-5216

## BLANK TAPES & CARTE BLANCHE

DOES YOUR PURCHASE of blank audio or video tape provide you with a carte blanche to infringe copyright? Apparently the Australian Copyright Council thinks it does. Proposals suggested in a lengthy report from the Council, recently presented to the Federal Attorney General's Department, would require purchasers of blank audio or video tape to pay a levy, the purpose of which would be to offset alleged losses of earnings of copyright holders brought about by unauthorised copying of recorded works.

The Federal Attorney General announced recently that audio-visual provisions of the Copyright Act will be reviewed. No doubt the question of the rights of copyright owners and consumers will be examined along with the idea of imposing a levy on blank recording media.

This question has been examined at length overseas. The British Government recently decided not to impose a levy on blank tapes as it would be an unfair impost on those who purchased blank tape for exchanging 'talking letters' or recording the baby's first words or similar purposes where recording did not involve copying of previously recorded material. (See our lead story in Sight & Sound this month, page 143).

It is perhaps significant that no country with British law has legislated to impose a levy on products where it may be possible to breach copyright. Even if such a levy were imposed it can be circumvented by selling tapes with prerecorded trivia on it at low level — even white or pink noise would probably suffice.

One can sympathise with performers, recording companies and other copyright holders who fear or believe that a substantial portion of their income is lost or eroded by people making unauthorised copies of their recorded works. But any claims are largely unsupported by statistics or reasonable estimates — principally because such figures are well-nigh impossible to obtain.

The situation has produced a 'Mexican standoff'. But is a levy the just way to go about righting a prima facie wrong? The whole issue is very complex and a ministerial 'review' of legislative provisions will not see justice done. A public inquiry would.

Roger Harrison  
Editor

*Roger Harrison*



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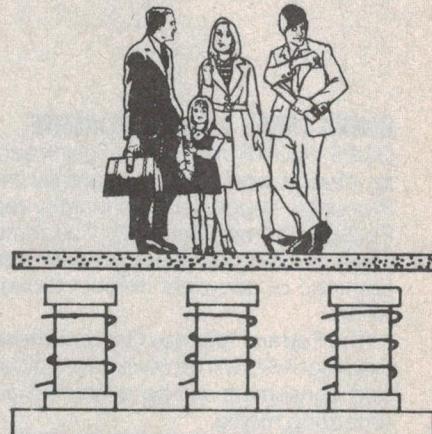
**eti** ELECTRONICS  
TODAY  
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**MAGNETIC LEVITATION**  
For Future Transport

Completing the  
660 LEARNERS'  
MICROCOMPUTER

**CARVER**  
Magnetic  
Field  
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Reviewed

# features



Magnetic levitation for transport applications has had its ups and downs ... but may come to fruition yet, according to this month's feature article. Cover design and layout by Ali White and Githa Pilbrow from an idea by Roger Harrison.

\* Recommended retail price only.

# MAGNETIC LEVITATION FOR FUTURE TRANSPORT?

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Dwindling energy supplies are making the concept of a magnetically driven train ever more attractive. Japan and West Germany have both made strides in this area, and now Canada joins in the development.

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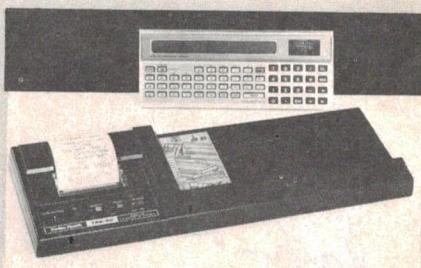
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Dick Smith's 'Shop by Computer'; The Source is with us!

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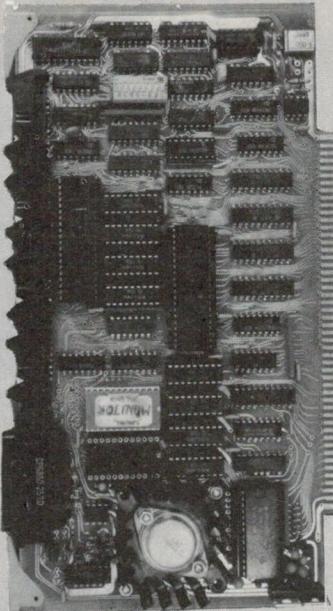
What to do with your ETI-660 while you're learning how to do things with your ETI-660!



## YOU'LL HAVE A SHANDY, THEN? 122

The Sharp CE-122 dot impact printer operates with both the Sharp PC-1211 pocket computer and the Tandy TRS-80 — hence the nickname 'Shandy'. Tom Moffat reviews it for us.

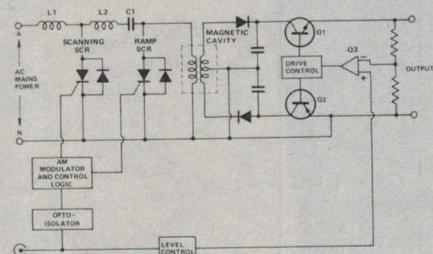
next month



## sight & sound

### HIGH PERFORMANCE AUDIO POWER AMPLIFIER 158

This high performance 25 W power amp features low harmonic and crossover distortion, stable bias current, large open-loop bandwidth to avoid transient intermodulation distortion, very good square wave response and relatively simple design.



### CARVER M400 MAGNETIC FIELD AMPLIFIER 166

The M400 embodies a totally new concept in amplifier design. It is claimed to overcome distortion problems and is based on a completely new approach to the basic power supply. Louis Challis examines it.

### DYNAUDIO 20-55 LOUDSPEAKERS 174

The Dynaudio 20-55 two-way speaker system is said to incorporate quite a few innovations which increase its efficiency and give it excellent stereo imaging and power handling. Louis Challis checks it out.

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# NEW ZEALANDERS ARE SAVING UP TO 75%

thanks to Dick Smith opening his first store in Auckland.

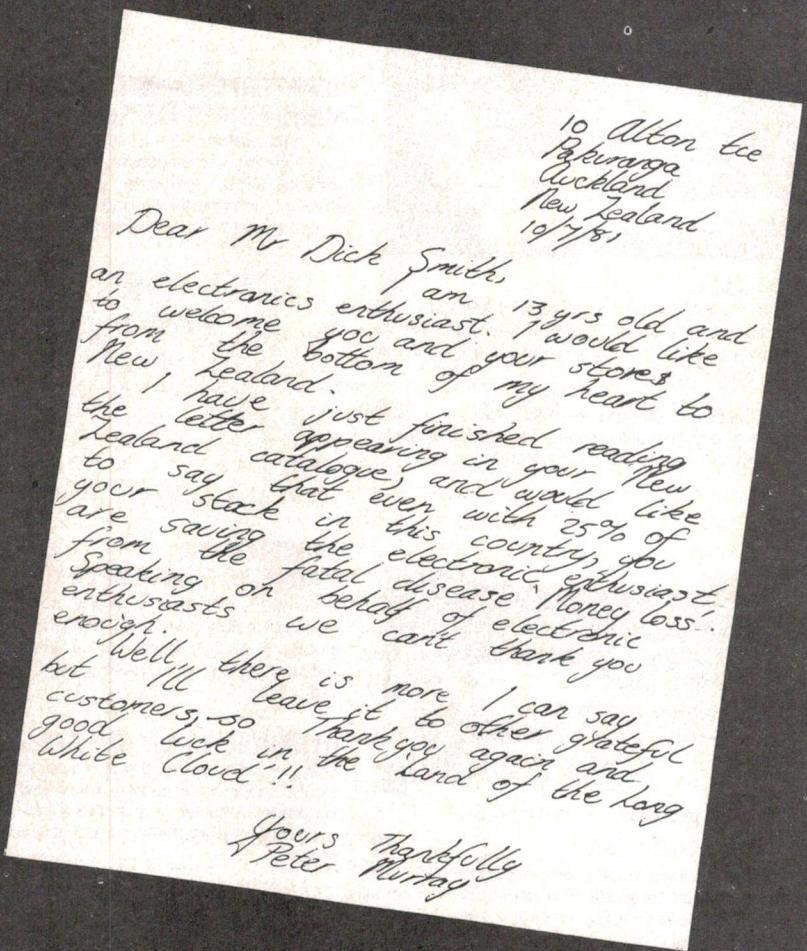
Dick is now able to give New Zealanders the same sort of savings available to his Australian customers.

and Peter makes  
**Dick Smith Electronics**  
feel at home . . .

Thousands of happy customers have called in to our Auckland store to thank us for opening in New Zealand.

Thirteen-year-old Peter Murray was typical of the letters we received: only he took the trouble to write to Dick directly.

To all of the Peter Murrays in New Zealand, Dick says 'Thank You. I'll continue to bring you the best in electronics at the lowest prices possible'.



Even if you don't live in Auckland, you can still take advantage of Dick Smith's low prices.

You can purchase from our wide range of items through our Mail Order Centre. Take advantage of our 14 years experience in mail ordering in Australia.

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our 1st Edition Catalogue.



## Australia — importing the future?

Many people in Australia, including the Governor-General and leading figures in the computer industry, have expressed the fear that Australia will soon be

**Mr. Paul Edwards, general manager and director of the Australian company Digital Electronics, which recently won an Industrial Design Council of Australia award for its efforts in designing a family of computers, claims that members of high technology industries are not arguing for protection merely to put money in their own pockets. The argument for protection is that as long as the quality is at least of the same standard as that of an overseas product, it is worth paying a premium for a local product because jobs are preserved and created.**

"If the Australian Government wants to help build a local industry and keep skilled people in Australia, the simple way is to support industry by local purchase," said Mr. Edwards.

"Each year at this time I get inundated with enquiries from university and technical college graduates wanting to participate in the manufacture of computers. They can only be involved if there is a vibrant high technology industry."

"Recently a high-school principal asked me why it was difficult to find jobs for some technically oriented school leavers who didn't want to go to university. I answered with a question: how many Australian-made computers, laboratory instruments, etc, have you got at your school? His reply was: none!"

"So where are our young

people to get their training? What will happen to the industry to which they are looking for employment? The abolition of tedious production line jobs is, according to government rhetoric, supposed to be replaced by jobs in the new technology.

"I fail to see what help this is to our young people if all the new technology jobs are overseas. And governments can hardly help to create jobs in private enterprise in Australia by buying from overseas.

"Technology is not like footwear or cheap clothing from Asia ... without our own technological reservoir we are completely vulnerable to the economic machinations of our competitors. We lose our most skilled and far-sighted citizens to overseas companies, and we export our resources for nothing more than a lease on the twentieth century."

The Governor-General, Sir Zelman Cowan, recently joined the argument by warning that Australia's dependence on imported technology could lead to vulnerability in time of war.

Mr. Edwards, however, sees the dangers of reliance on imported technology and the lack of encouragement for local production as more far-reaching than merely military.

"The nation may survive a threat of war, but in the meantime its industry — which supports the people — may wither through government neglect ... it (is) even more surprising that the Federal

importing its future from overseas if there is no change in Federal Government policy on preference for local technology.

Government in a pre-Budget decision abolished its own purchasing policy of preference for locally manufactured goods — a decision which means that Australian industry is now likely to become even more dependent on competing nations for technology.

"While other countries and organisations like the EEC practise protection for their products, the Federal Government seems to have decided that Australia will make a unilateral and pointless act of self-sacrifice.

"Last year more than \$500 million in computer equipment was imported into Australia. Much of this was bought by governments — a massive support of overseas industry that does nothing for the Australian economic environment."

A recently formed group — the Association of Australian High Technology Industries (AAT) — is concerned with precisely the same problem as that outlined by Mr. Edwards, and has as its aim the furthering and promotion of indigenous high technology industry.

The AAT's interim president, Mr. Will Fiala, said that stress would be placed on the 'home-grown' high technology industry's ability not only to generate considerable employment but also to remove both economic and military dangers to the Government and the community in terms of over-reliance on overseas products.

Mr. Fiala said the AAT would

also lobby hard to attract venture capital to aid sound, planned growth in the industry. The AAT would mount an educational and marketing program and seek to change all Australian governments' attitudes towards local aid.

The AAT has said it will seek to work closely with the trade union movement in Australia, not only to overcome the fear of the introduction of high technology but also to gain support to reverse the trend to import this technology when it is readily available here.

According to Mr. Fiala, the group has already attracted considerable interest from Federal and state government departments, from consultants and from many other potential members. Membership is open to Australian high technology companies, and a brochure about the group and its aims, including an application form, is to be distributed widely throughout Australia.

A major conference/symposium is planned for November, in which the AAT will strongly put its case for the planned growth of the Australian high technology industry.

Mr. Fiala, who is managing director of the Melbourne-based company Alfratron, may be contacted on (03)758-9551. A spokesman for AAT, Mr. Simon Feely, is available on (03)62-1176, and the Association may be contacted via GPO Box 1800Q, Melbourne Vic 3001, or at the 2nd Floor, 349 Collins St, Melbourne.



## 4 3/4-digit LCD multimeter

The Thurlby 1503 4 3/4-digit LCD multimeter is being introduced by Parameters Pty Ltd at a price more commonly associated with 3 1/2-digit meters.

The 1503 has a scale length of 32 768 counts ( $\pm 15$  bits); this extra resolution enables it to monitor a 1 mV change in a 30 V power rail, for example, when a 4 1/2-digit meter would be limited to 10 mV and a 3 1/2-digit meter to 100 mV. The high resolution also virtually eliminates inaccuracy caused by digitising error.

Thirty measuring ranges are provided, plus diode test and

frequency measurement functions, and the instrument is claimed to have good noise rejection and a high sensitivity. Primarily intended as a laboratory instrument, the low power circuitry nevertheless gives it 200 hours of operation from batteries.

For further information contact Parameters Pty Ltd, PO Box 573, Artarmon NSW 2064. (02)439-3288.

## Battery technology '81

A one-day seminar on electrical batteries will be held at the Faculty of Military Studies of the University of New South Wales at the Royal Military College, Duntroon, on Tuesday, 10 November, 1981.

Some twelve papers will be presented from industry, research establishments and the Department of Defence. Topics to be covered range from the characteristics of carbon-zinc primary batteries, through present practice of rapid charging of nickel-cadmium cells and recent progress in lead acid accumulator design, to lithium storage batteries for solar energy.

The seminar is directed mainly to batteries now available or going into production, and should be of particular interest

to those concerned with the design of battery-operated equipment or battery procurement.

The conference is open to anyone, although accommodation is limited, and the \$15 fee covers registration and a bound copy of all papers, which will be sent prior to the conference to all who register.

Further enquiries can be addressed to: Mr. C.G.J. Streatfield, Department of Electrical Engineering, Royal Military College, Duntroon ACT 2600. (062)66-3583 or 66-3707.

## Popular transformers from Rod Irving

Rod Irving advises that he is now stocking three low-voltage transformers that deliver popularly required voltages and currents, all listed at competitive prices.

The R-2851 has a 12.6 V multi-tap transformer, which centre-tapped secondary rated at 150 mA. Next in line is the R-2155, which has a multi-tap secondary that provides 6.3, 7.5, 8.5, 9.5, 12.6 and 15 volts at 1 A. Last is the R-6672, another

Further details from Rod Irving Electronics, 425 High St, Northcote 3070 Vic.

## Aegis and FRL sign agreement

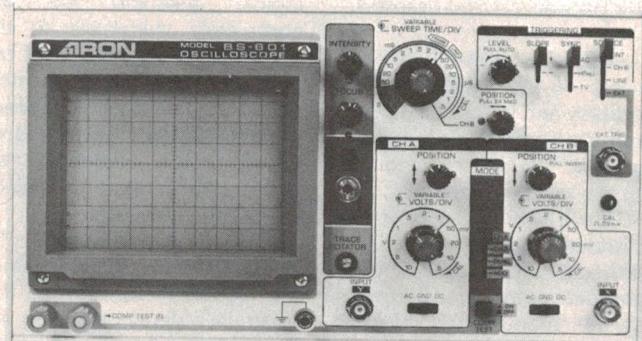
Aegis Pty Ltd of Melbourne has been appointed sole Australian agent for Fisher Research Laboratory Inc of the USA.

FRL has specialised in underground metal detection for fifty years, and were granted the first metal detector patent in 1937. Their industrial products include pipe and cable locators, cable fault locators, water leak detectors and water level indicators. Aegis will also distribute FRL's consumer lines, which include the 'M-Scope' treasure and gold detector.

Alan Bradley, Marketing Manager for Aegis, recently

visited FRL in Los Banos, California, and spent several days in practical field work associated with the application of Fisher underground metal detection equipment. This experience should help Alan to provide full back-up support for Australian users of Fisher equipment.

For further information contact Aegis Pty Ltd, 141 Christmas St, Fairfield Vic. 3078. (03)481-1422.



## Component-checking 'scope

Aaron Corporation recently incorporated a new test feature into their 20 MHz scope, the BS601, available from Elmeasco.

The BS601 is a dual-trace 5 mV/div instrument said to be ideal for service, TV and digital work. Its unique feature is the front-panel provision of terminals for checking passive components. A test signal of 2 mA maximum is applied to

the component and a corresponding digital display produced on the screen.

Further details on the BS601 are available from Elmeasco Instruments Pty Ltd, PO Box 30, Concord NSW 2137. (02) 736-2888.



## New Beckman multimeters

Warburton Franki recently announced the introduction of two new Beckman bench-top 3½-digit multimeters to supplement its line of handheld portables.

These two new meters, designated the Tech 350 and Tech 360 meters, are designed for use by electronic engineers, technicians and hobbyists.

Both feature 12 000-hour battery life, 0.01 ohm resolution, diode and transistor check, high overload protection, visual and audible continuity selection, 0.1% basic dc accuracy, and a

single rotary switch that selects 31 ranges in eight different functions.

The Tech 350 is an average responding meter. The Tech 360 is a true RMS meter with built-in temperature measuring capability.

For further information contact your local Warburton Franki office.

## Cool it, man!

**There's no longer any need to get hot under the collar about cooling problems since Cambion introduced their low-cost thermoelectric cooling modules.**

Distributed locally by Electronic Development Sales, these modules have a wide range of uses. You can make a water cooler, refrigerator, cold source, etc, from these simple packages.

Basically, they consist of a semiconductor junction that pumps heat from one face to another when a bias voltage is applied. This is known as the 'Peltier Effect'.

The ability of these devices to get rid of heat is truly amazing. Take the Cambion module type 801-2003-01-00-00, for example (try saying that in one breath!). Driven from an 8 Vdc source, it will draw around 5.5 A and has a maximum heat pumping capacity of 27 watts or

greater. The maximum temperature difference between the faces of the module can be 60°C or greater and the hot side temperature may be 50°C. Not bad for a module that measures only 32 mm square by 3.8 mm thick!

Cambion have published a 28-page application notes manual that is chock-full of theoretical and practical notes if you're interested in exploring the subject of thermoelectric temperature control.

Further information can be obtained from Electronic Development Sales Pty Ltd, 92 Chandos St, St. Leonards (P.O. Box 217) NSW 2065. (02) 438-2500.

### ERRATA

The ETI-154 Logic Pulser Probe in the July '81 issue has a designation error on the circuit diagram on page 55. IC1a is shown as an inverter where it is actually connected as a buffer. The output is pin 3 (goes to R3).

## Seminars for school electronics teachers

Royston Electronics, who have some twenty years' experience in electronics production, are now making their knowledge available to teachers concerned with electronic projects in schools.

This will be done by means of a series of seminars, to include printed circuit board fabrication, etching, drilling, etc; the use of hand tools and work holding devices; solderability and soldering techniques, etc, etc.

Whilst Royston Electronics are involved with the highly sophisticated high-volume equipment now used in industry, the seminars will include demonstrations using the high-quality/small-volume

equipment suitable for use by teachers in the classroom environment. This means that the techniques can be duplicated for the benefit of students.

Enquiries regarding the seminars should be directed to Mrs. P. Fleming, Royston Electronics, 27 Normanby Road, Notting Hill Vic. 3168, (03)543-5122, or Mrs. K. O'Regan, Royston Electronics, 15/59 Moxon Road, Punchbowl NSW 2196, (02)709-5293.



## Automatic LCR bridge from AWA

**The North Ryde division of AWA now has available an automatic digital bridge for measuring inductance, capacitance, resistance and Q.**

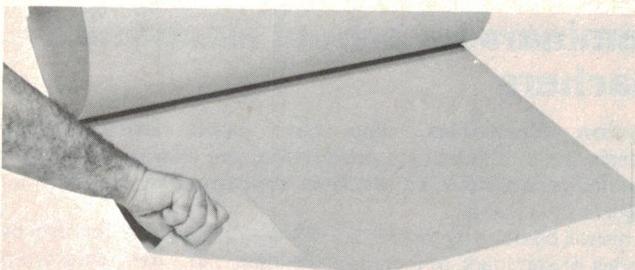
The AIM LCR Databridge 401 is an auto-ranging auto-function bridge which is said to need a minimum of operator intervention to obtain fast, accurate readings of LCR and Q. Two measurement frequencies, 100 Hz and 1 kHz, and parallel or series circuits are available to the operator, and if the value being measured is too large or too small the display will show 'or' (over range) or 'ur' (under range).

Range indication is by nine

LEDs, showing pF, nF, μF, Ω, MΩ, μH, mH and H. When measuring Q all LEDs are blanked.

With a basic accuracy of ±0.25% of the reading, the ranges are: 0 to 100 MΩ, 0 to 9999 H, 0 to 9999 μF and Q 0 to 99.

For further information contact Amalgamated Wireless (Australasia) Ltd, 422 Lane Cove Rd, North Ryde NSW 2113. (02)887-7111.



## Static protection for benches and desks

**Static-dissipative desk and bench covers of soft vinyl to protect microcircuit products from static electricity damage during production or in use are now available from Royston Electronics.**

The top side of this 'Stat-Mat' is textured to prevent eyestrain from glare and to keep computers, terminals, word processors and other micro-computer-based equipment from sliding. 'Stat-Mat' also has a layer of continuously conductive vinyl laminated between two layers of soft vinyl. This prevents deterioration of static protection qualities from water, cleaning solvents or surface abrasions, and prevents sloughing of particles, making it usable in clean rooms.

Because the electrically conductive material is a homogenous mass conductor rather than a scrim, conductivity is greater and cannot be broken by tearing.

Colours are light blue and beige. The covers are available in 60 cm and 120 cm widths, cut to any length up to 100 feet.

Further information is available from Royston Electronics, 27 Normanby Road, Notting Hill Vic. 3168, (03)543-5122, and 15/59 Moxon Road, Punchbowl NSW 2196, (02)709-5293.

## STC-Cannon to distribute Hitachi semiconductors

**STC-Cannon Components Pty Ltd has become a distributor for Hitachi semiconductors in Australia.**

A full range of Hitachi's 6800 CPU and peripherals will be available off the shelf at all STC-Cannon sales offices throughout Australia. Mr Brian Maloney, said the Hitachi products would be a significant and complementary addition to the extensive range of semiconductors handled by STC-Cannon.

The director of marketing of STC-Cannon Components,

This contest, featured in our July issue, attracted quite a pile of entries from all over the country. The five multiple-choice questions certainly sorted out who was on the ball with their homework — all you had to do was search back through your 1980-1981 ETIs to find the answers. Quite a few entrants managed to do this successfully, so we were left with judging answers to the 50 word essay question. The most imaginative answer, we thought, came from:

### R.S. COX of HAMILTON SOUTH NSW

Congratulations, Mr Cox, your Radofin Adam 180 Teletext Adaptor, courtesy of Radofin Electronics (Aust.), is on its way to you.

Here are the correct answers to the five multiple-choice questions followed by the winning essay on which feature of Teletext appealed most to Mr. Cox.

## Analogue memory modules go digital

**A new range of analogue memory modules from Xebec Co Ltd is now offering indefinite analogue input signal value retention in the HOLD mode.**

This is achieved by converting the analogue input signal into a digital signal inside the modules, all internal signal processing being done in the digital form. The output signal is again an analogue signal obtained from the digital signal by D/A conversion.

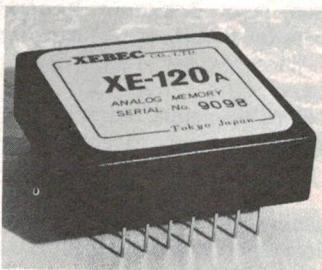
The modules can be used simply as analogue memories or used to construct a feedback control loop for controlling analogue signals. If used in a control application the response speed of the module can be adjusted externally, and the required resolution determined by the choice of modules.

All units have memory capability in the event of momentary power failure and, if using the

non-volatile option, this is extended to about one year without the use of batteries!

These modules feature full pin compatibility between the 8, 10 and 12-bit units.

For further information contact Alfatron Pty Ltd, 1761 Ferntree Gully Rd, Ferntree Gully Vic. 3156. (03)758-9551/758-7581.



### OUR BINDERS ARE BIGGER!

That's because ETI is bigger every month, on average, than any other Australian-published electronics magazine, and 12 issues will not fit in commonly available binders.

You can just fit the 1979 issues in the 'old' binders, but 1980 is a different story! And 1981 will be the same. So we've arranged to have bigger binders made to take the increased thickness of ETIs, as we know that many of you good readers like to keep your past issues.

If you too would like to keep ETI's "... articles of lasting interest" protected and in order, then our sturdy binders, finished in brown vinyl with the magazine's title printed in gold on the spine, can be obtained for a mere \$6.10 by NSW readers or \$7.50 for readers in other states, post paid. Send your cheque or money order to 'ETI Binders', ETI Magazine, 15 Boundary St, Rushcutters Bay NSW 2011.

### RESULTS: ETI/Radofin Teletext Contest

1. Are Teletext signals synchronised with the TV line frequency? Yes.
2. Can the Teletext display be superimposed over the normal TV picture when using the Radofin adaptor? Yes.
3. The release of the Radofin Adam 180 Teletext Adaptor was announced in which issue of ETI this year? April. (Radofin's first advertisement, announcing the unit, appeared in March, and so those answering March were counted as correct).
4. When did Teletext officially go into service in Australia? 4 February 1980.
5. About when did TV stations first start test transmissions of Teletext signals? March 1977.

"Teletext appeals because it extends the use of the domestic television set to an information system which combines the immediacy of broadcasting with the longer-term accessibility of a newspaper."

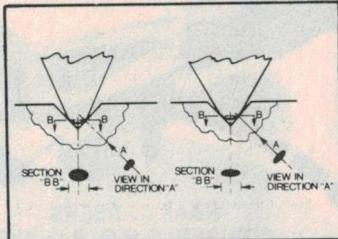
# fact: dramatic freedom from distortion comes to a mid-priced cartridge: the new Shure M95HE...



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One of the critically acclaimed advances introduced in Shure's incomparable V15 Type IV pickup is its revolutionary and unique distortion-reducing Hyperelliptical stylus. Now, you can enjoy this standard of sound purity in a new, ultra-flat frequency response, light tracking, high trackability cartridge that will not tax your budget: the new Shure Model M95HE.

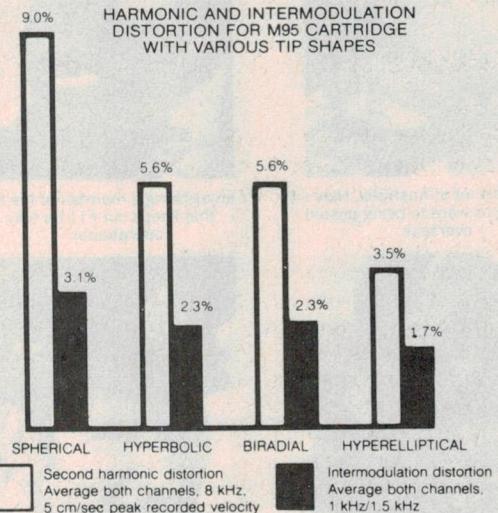
## the Hyperelliptical stylus tip



BIRADIAL (ELLIPTICAL)  
STYLUS SUCH AS  
IN M95ED

The Hyperelliptical nude diamond tip configuration represents a significant advance in tip design for stereo sound reproduction. As the figures show, its "footprint" (represented by black oval) is longer and narrower than the traditional Biradial (Elliptical) tip-groove contact area. Because the Hyperelliptical footprint geometry is narrower than both the Biradial and long-contact shapes such as the Hyperbolic, it is pre-eminent for reproduction of the stereo-cut groove.

HARMONIC AND INTERMODULATION DISTORTION FOR M95 CARTRIDGE WITH VARIOUS TIP SHAPES



## a measurable drop in distortion

As a result of the optimized contact area of the Hyperelliptical tip, both harmonic distortion (white bars in graph above) and intermodulation distortion (black bars) are dramatically reduced.

**upgrade your present M95** If you already have a Shure M95 Series Cartridge, you can improve its freedom from distortion right up to the standards of the new M95HE cartridge simply by equipping it with a Model N95HE stylus. The cost is extraordinarily low — yet the difference in sound will be immediately apparent. Takes only seconds to install — requires no tools whatsoever.

## M95HE cartridge & N95HE stylus



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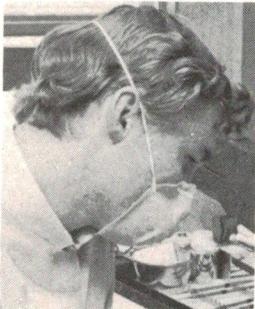
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## First for HP scientists

Scientists and engineers of Hewlett-Packard laboratories in Palo Alto, California, have revealed in four technical papers a new electron beam lithography system that promises, using direct writing, to make production quantities of ICs of greater complexity than any yet seen. The system appears to be the first of its kind.

New levels of speed and accuracy were cited by the firm as reasons for expecting the system to make so large a forward step in the integrated circuits 'art'.

The ability of the HP system to produce patterns of extreme complexity at high production rates rests largely upon the achievement of a 600 nanoampere, 0.5 micron beam that can be blanked at a 300 MHz rate (i.e. exposing 1 pixel every 3.3 ns) while the beam is placed anywhere in a field of view of 11.7 x 11.7 cm, with accuracy of  $\pm 0.125$  micron.

According to HP, there is every indication that ICs of 1 micron geometry will be routinely producible by the equipment. A beam-produced 2.6 GHz surface acoustic wave resonator with 0.3 micron lines and spaces has been demonstrated.

The HP E-beam lithography system is documented in detail in the May 1981 issue of the Hewlett-Packard journal. Copies are available from Hewlett-Packard Australia Pty Ltd, PO Box 36, Doncaster East Vic. 3109.

## Vicom lab power supply

Vicom International has available a new laboratory-type dc power supply which incorporates pulse switching, thereby eliminating bulky transformers.

Produced by the Daiwa Corporation of Japan, this power supply has variable voltage output between 9 and 15 volts, and a maximum current rating of 30 amps.

Using Daiwa's crossed-needle indicating meter system, voltage output and current are automatically read, and wattage is additionally read on the calibrated scale at the point

where the needles intersect. The efficiency of the supply is claimed to be 75%, with voltage regulations better than 0.5% at the maximum current of 30 amps.

Further details and pricing are available from Vicom International, 68 Eastern Rd, South Melbourne Vic. 3205. (03) 62-6931, or the Vicom Sydney office on (02)436-2766.

## Texas Instruments report

A new 16-page application report, 'Power Transistor Voltage Ratings and RBSOA Curve', is available free from Texas Instruments sales offices throughout Asia and Australia.

The new report (SCA-202) discusses experiments which reveal how power transistors measured voltage characteristics, particularly VCED (SUS) and VCEX (SUS) and the reverse bias safe operating area (RBSOA) verified capability, actually relate to a device's high voltage switching capability.

Test experiments included in

## Has pen, will write

The documentation supplied with electronics instruments, devices or kits is an important part of the overall 'package', and a product's success can stand or fall on the documentation — as pointed out in the Editorial of the September ETI.

Teknidata Services was set up in mid-1980 by Andrew Kay, a self-employed technical writer, with the aim of providing a professional, personal service in the field of technical communication. Andrew's experience includes a solid practical background as an electronics technician/technical officer in communications, process control, data logging, laboratory instrumentation and bio-electronics.

This practical background, coupled with the last nine years as a professional technical writer working on military and commercial handbook research and preparation, enables Teknidata to offer a genuinely useful service in the preparation of all sorts of technical documentation, Andrew claims.

The services are offered either on a 'whole job' basis or 'in-house' at the client's premises, and extend to much more than just the writing component. Painstaking research, careful validation and the willingness to see the job through to the 'nitty-gritty' end of hassling with printers, layout

artists, typesetters and the like are, according to Andrew Kay, the keys to a successful publication project — be it a simple technical sales brochure or a complex, multi-volume manual.

At present the company offers the following documentation services:

- research, writing, editing and production of customer-oriented documentation — i.e.: sales brochures, ad copy, product specifications, operating and technical handbooks, parts lists and catalogues;
- kit-assembly manuals, fault-finding guides, detailed procedural instructions of all kinds;
- preparation of company and personal resumes, technical proposals, quotations;
- project management of documentation jobs — i.e.: co-ordinating and controlling the preparation, illustration, paste-up, photography and printing for a publication or leaflet.

For further details, quotes, etc, contact Andrew Kay at Teknidata Services Pty Ltd, (02)519-3749.

## New switch guide

The Components Division of IRH has released a new four-page guide to the Fujisoku range of subminiature toggle and pushbutton switches. Most types are available for immediate delivery in quantity.

Toggle types include waterproof, flat, locking, vertical and right-angled mounting switches, and pushbutton switches are available in conventional and waterproof versions.

The guide (SW2/1981) also gives details of accessories,

including coloured caps and mounting hardware, plus full electrical and mechanical specifications.

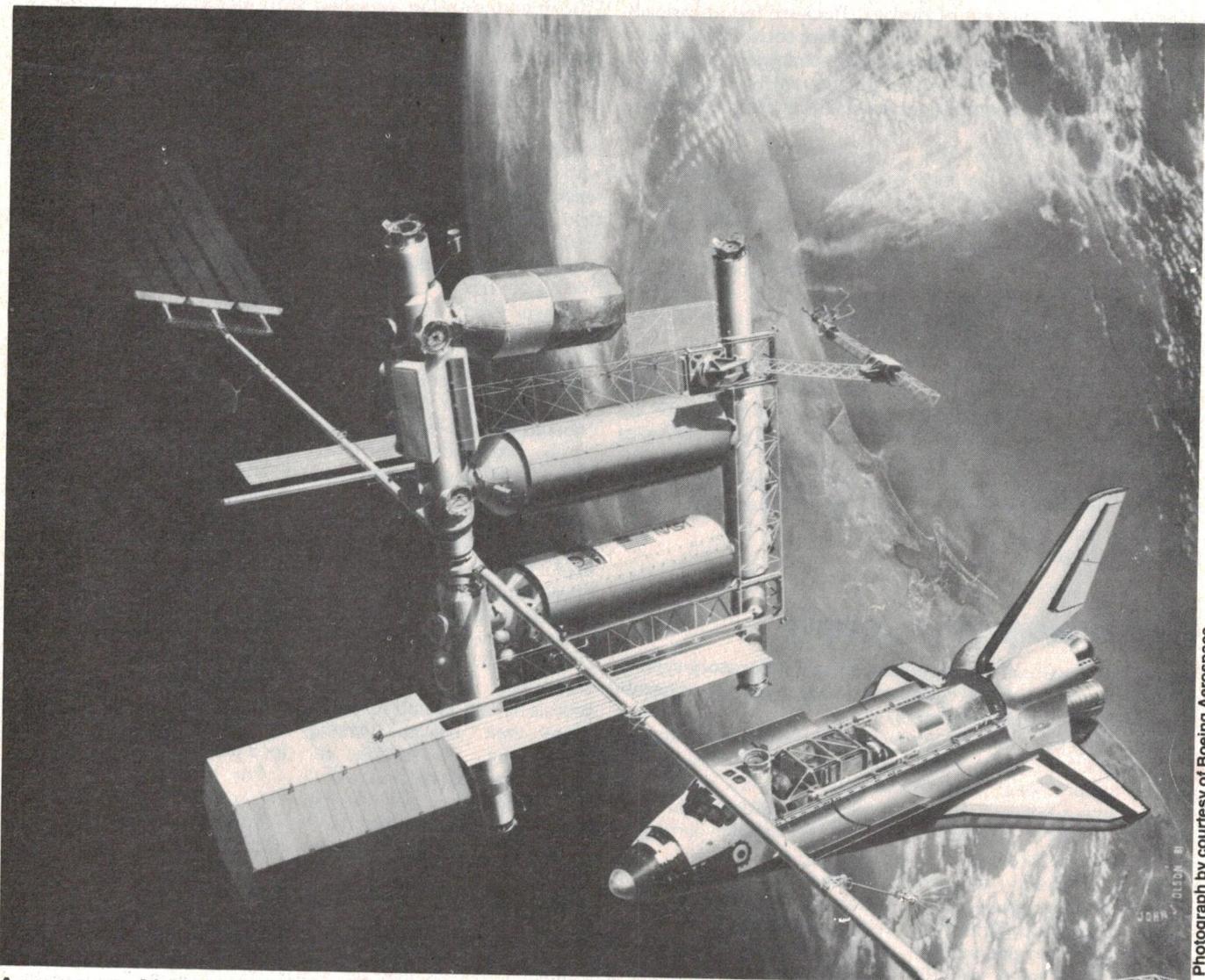
Copies of the guide are available from IRH Pty Ltd, 53 Garema Circuit, Kingsgrove NSW 2208. (02)750-6444.

## Martin de Launay in Kingswood

Martin de Launay Pty Ltd, wholesalers and importers of electric, electronic and mining supplies, recently opened a new branch in Kingswood, managed by Mr. Arthur Higlett.

The address is Unit 1, 4-6 Phillip St, Kingswood NSW 2750. (047)32-2081. Hours are Monday to Friday, 7.30 am to 5 pm.

## Permanently orbiting spaceport for NASA



Photograph by courtesy of Boeing Aerospace.

**A spaceport which would permanently orbit the earth at an altitude of some 200 to 250 miles has been designed by Boeing Aerospace as the first phase of a study for NASA.**

Such a space operations centre would be permanently manned, with the crew members staying there for about 90 days before returning to earth. The design includes two 'habitat' areas which would serve as living quarters, each being roughly the size of a large mobile home, containing command control, food preparation, health maintenance and recreation areas for a normal crew of eight people.

The aim has been to develop an orbiting facility with mainly

operational rather than only scientific functions. The unit would serve as a staging point, rather like a base camp in a mountain climb. Large orbiting systems could be constructed and checked out at the centre, whilst free-flying satellites could be tended and space-based vehicles serviced, launched and recovered.

The modular construction of the spaceport is well shown in the photograph, and the following components should be easily made out:

1. Flat panel radiator — the long, striped panel adjacent to the orbiter.
  2. A large hexagonal hangar for servicing and storing spacecraft.
  3. Two cylindrical modules containing propellant, batteries, power processing units, oxygen and nitrogen.
  4. A solar array attached to a long boom. A second array (not shown) is at the other end of the boom and together they provide power for the spaceport.
  5. A shorter logistics module (partially covered with thermal insulation), which serves as a storeroom for consumables such as food, water and hydrazine propellant.
  6. Track or truss structure and 'cherry picker' crane used for handling spacecraft.
  7. A tube-like docking module (adjacent to the base of the crane) used primarily for docking spacecraft or building other structures. Here the Space Shuttle Orbiter can be seen in docking position.
- If NASA decides to order such a spaceport, it could be constructed in the late 1980s, initially for use by a crew of only four.

**Brian Dance**

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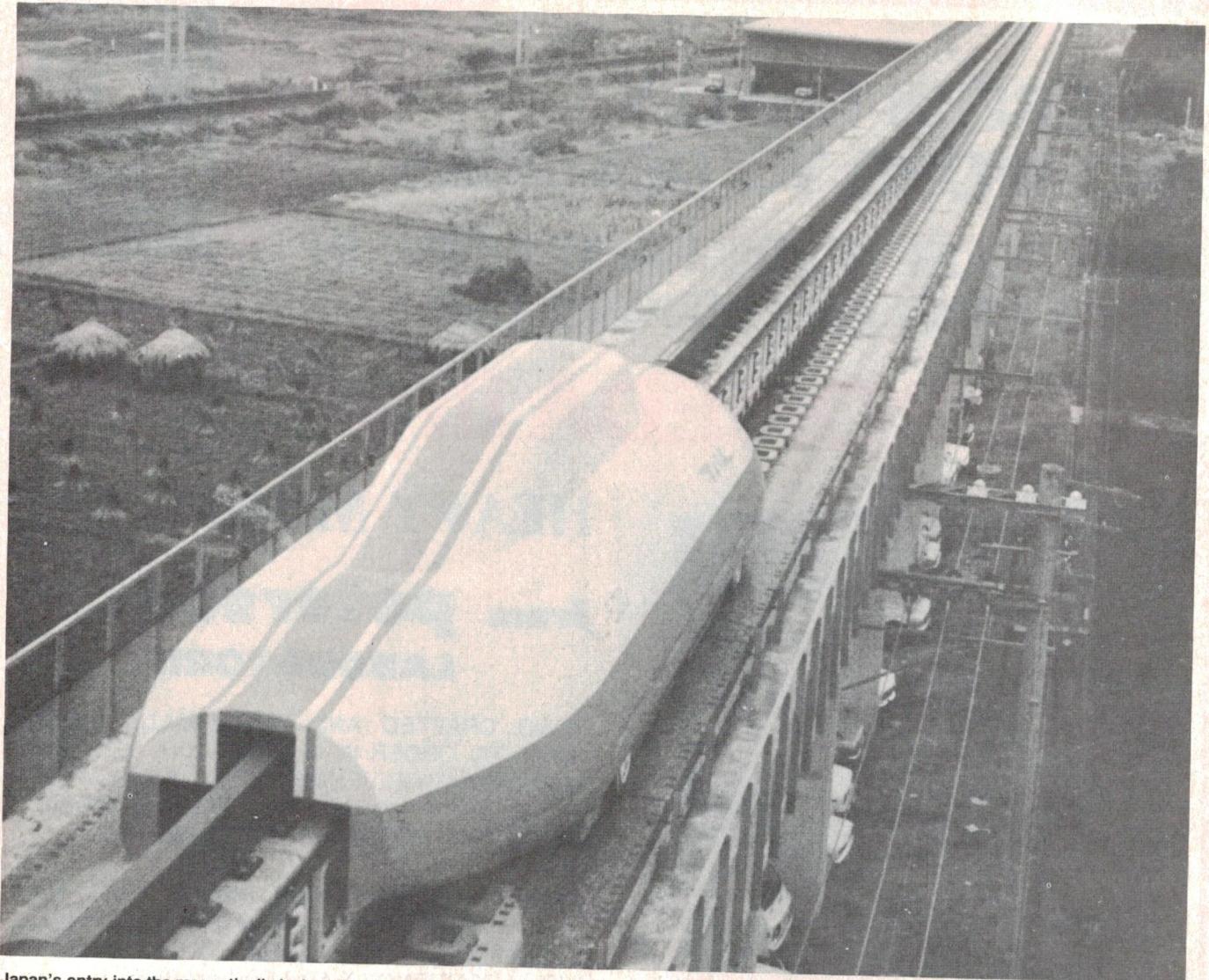
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Japan's entry into the magnetically levitated concept is shown on its test track. This prototype has achieved speeds up to 500 km/h. (Photo: courtesy of Japanese National Railways.)

## Magnetic levitation for future transport?

Dwindling energy supplies are making the concept of a magnetically driven train appear attractive. The Canadian National Research Council's Division of Mechanical Engineering recently completed a study on the possibilities of such a system.

HYDROCARBON FUELS, the main-stay of today's travel, are in dwindling supply. Fuel price increases are front-page news and real cost of transportation is coming under close scrutiny. Airlines, for example, are

finding the cost of flying a commercial jet aeroplane from Sydney to Canberra is proportionally higher than from Sydney to Perth. Fuel-expensive take-offs and landings must be offset by higher passenger revenues on such

short hauls. Beyond the flight, the passengers themselves frequently must add the cost and time of further transport to city centres. Suggested alternatives, such as short take-off and landing (STOL) aircraft, air cushion

vehicles (ACVs), or high speed trains have been proposed as interim solutions. Yet another alternative, a magnetically levitated vehicle (MAGLEV), has been under evaluation by the university community, industry and the Canadian National Research Council.

To properly understand what a magnetic levitation system is, it is necessary to recall the toy magnets of childhood and the discovery that one magnet makes another 'float' in air. When engineers coil a wire around an iron core and apply an electric current, the power of the resultant magnet is increased and the toy becomes a tool.

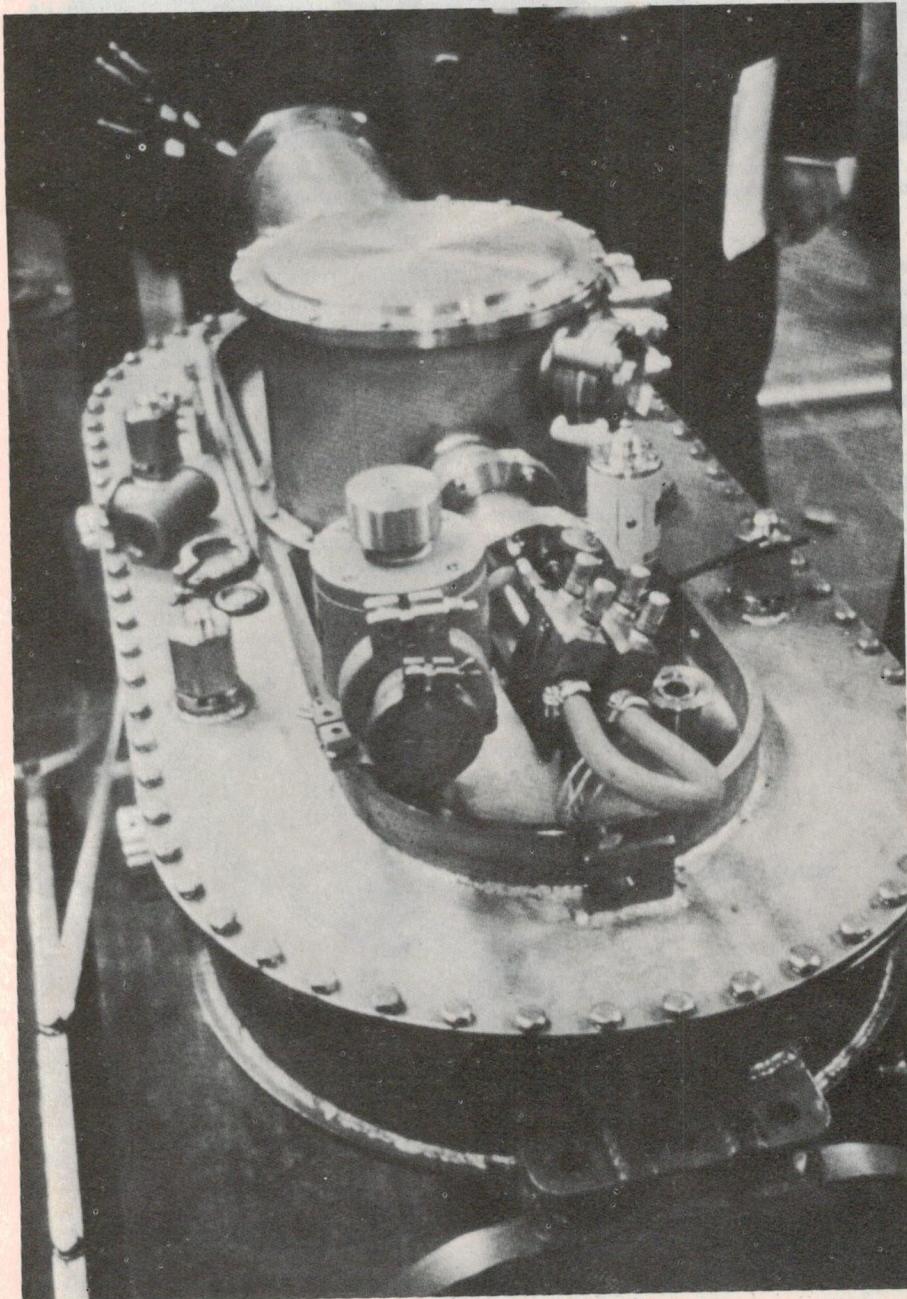
Early in this century, researchers attempted to use the electromagnet concept to 'lift' vehicles, with the intention of providing frictionless, high speed transport over moderate distances. However, these early studies indicated that the necessary technology could not create a commercially feasible system. As a result, the idea of using magnetic levitation for travel was shelved for many years. Today's technology, however, in particular the advent of superconducting wires, has allowed engineers to develop the earlier ideas, and to conceive a complete system based on repulsion lift (rather than the somewhat older attraction lift concept).

The Canadian NRC has been investigating a repulsion MAGLEV for some years.

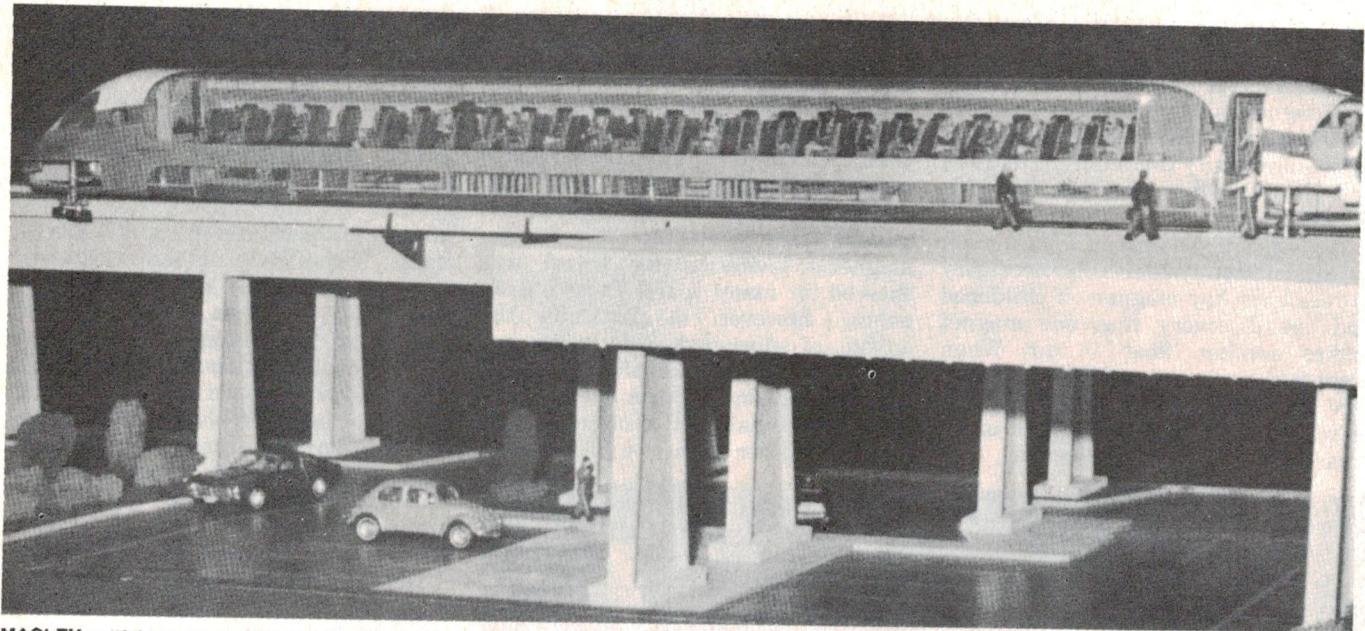
W.F. Hayes, of the Division of Mechanical Engineering, authored a report examining the engineering feasibility of a high speed MAGLEV system. In summarising the events leading to the conceptual study, Hayes states: "There were numerous threads to tie together in establishing the practicality of such a system. We started at the bottom — the track. Several configurations have been considered, both here and abroad — but in Canada the chief problem is snow on the tracks. After a number of winter tests of full-sized track forms, a flat track was shown to be best, as it is self-cleaning — the snow simply blows off before packing into ice. At the beginning, therefore, we established that the clearance between track and vehicle could be generous, which allows us to use conventional reinforced concrete construction methods and avoid expensive close tolerance techniques.

"Track design was followed by an investigation of the type of vehicle that would work best on the flat track," continues Hayes. "Instead of setting a figure on the number of passengers we should carry, we determined the most energy-efficient vehicle form and derived how many passengers it would carry. A relatively long, 3 m wide cross-section evolved; a width ideal for a first-class accommodation plan of two-by-two seating and economy class of two-by-three. At the same time, we performed a number of aerodynamic tests to determine the frontal shape best suited to our needs and, behold, we came up with what looked like a DC-9 without wings, stabilisers or engines. These studies also enabled a design team at the Council's Division of Mechanical Engineering to calculate anticipated weights, which showed that the MAGLEV train could carry twice the revenue load of a comparably sized aircraft. This proved to be a real breakthrough, demonstrating that MAGLEV could be revenue competitive with aircraft on short haul (500 km) runs."

MAGLEV propulsion methods remain a major design consideration. "Although early work concentrated on 'lifting' the vehicle," explains Hayes, "ideas on propulsion which could be successfully coupled with frictionless suspension were being investigated by design teams in a number of countries. The Americans initially proposed a gas turbine engine. That tied them to such problems as carrying fuel, reducing revenue payload weight, fire hazard, exhaust and noise pollution, with the added headache of engine maintenance ►



Prototype West German superconducting magnet for MAGLEV vehicle. (Photo: Siemens Research Laboratories, German Federal Republic.)



MAGLEV model constructed by technicians at NRC's Division of Mechanical Engineering portrays the train taking on passengers and cargo at 'Ottawa' station. The model shows flat track cross-section and outrigger wheels deployed when train is stopped or operating at slow speeds. (Photo: Mansell Acres, DME Canada.)

time. Other MAGLEV propulsion concepts have centred on linear electric drives."

The development of superconducting wires in the 1960s has permitted pursuit of more revolutionary drive concepts. Electrical conductors, cooled to close to absolute zero temperature, exhibit a sharp drop in resistance. To accomplish this, electrical wires are enclosed in a liquid helium environment, efficiently producing strong magnetic fields. These intense fields allow the vehicle to be lifted off the 'track' as well as providing the means to propel MAGLEV to its destination. For propulsion, a travelling magnetic wave is generated in windings in the track, which couples with the superconductors mounted in the base of the vehicle. The travelling wave then 'pulls' the vehicle along the track.

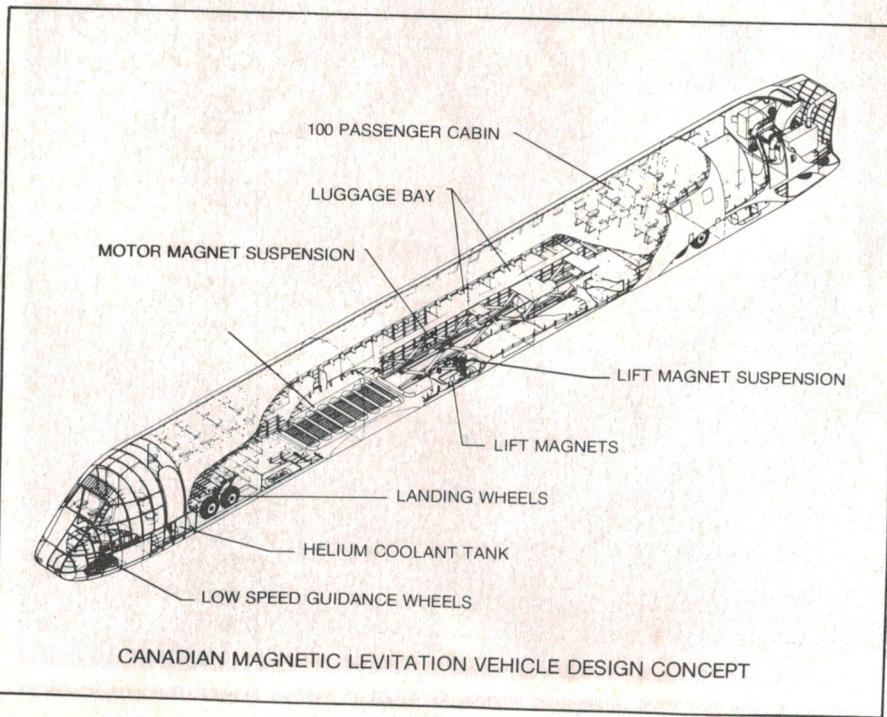
"A great deal of development has been done on superconducting linear magnetic drives in the last few decades," says Hayes. "German, Japanese and American scientists have examined the engineering problems with considerable success. Studies in Canada took place at Queen's University in Kingston, Ontario, during the early 1970s, on what is called a 'linear synchronous magnetic drive' for MAGLEV. The theoretical work done by a University of Toronto group and a full-scale experimental study of the drive at Queen's and NRC gave us a basis for our conceptual design of the system."

"Part of our study involved the in-

vestigation of 'fail-safe' requirements for the system," notes Hayes. "For example, the lift and drive magnets in the vehicle are cooled by jackets containing liquid helium. Should these cooling systems fail, the train will not run. That is one of our biggest problems — to come up with a highly reliable and lightweight refrigeration system. The Japanese have made great strides in cryogenics (low temperature engineering), and our report recommends further work in this area, especially in

improving reliability."

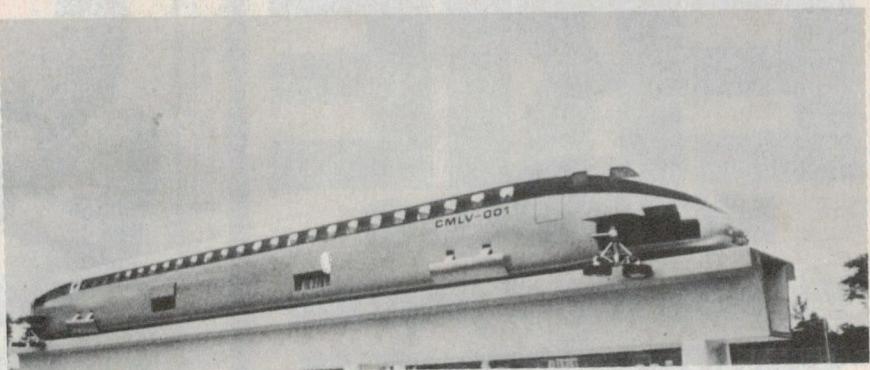
If the superconducting magnet system for MAGLEV is in the realm of future technology, the rest of the system is in what can be called an 'off-the-shelf' state of the art. "Nearly all of the concept we proposed in the report is well within today's technological range," says Hayes. "Vehicle configuration is not only similar to present jet aircraft in external appearance, but a good many construction techniques in that industry could be applied as well. In fact,



the construction of a MAGLEV vehicle would be simpler than an aircraft and calculating the loads or carrying weights on MAGLEV is much easier than on aircraft."

Hayes and his team were able to demonstrate that a MAGLEV system for short hauls is technically possible within the foreseeable future — if such a system is desired. "But MAGLEV is not a transportation cure-all", he stresses. "Some very basic decisions will have to be made over the next few years. We've extended the concept of MAGLEV from a high-speed ground-level replacement for commuter aircraft to an energy-competitive system. However, we cannot dodge the fact that for MAGLEV to come into being, a massive outlay in capital will be needed. A completely elevated track system would have to be built, electric power networks installed, stations built and the vehicles constructed — a monumental effort."

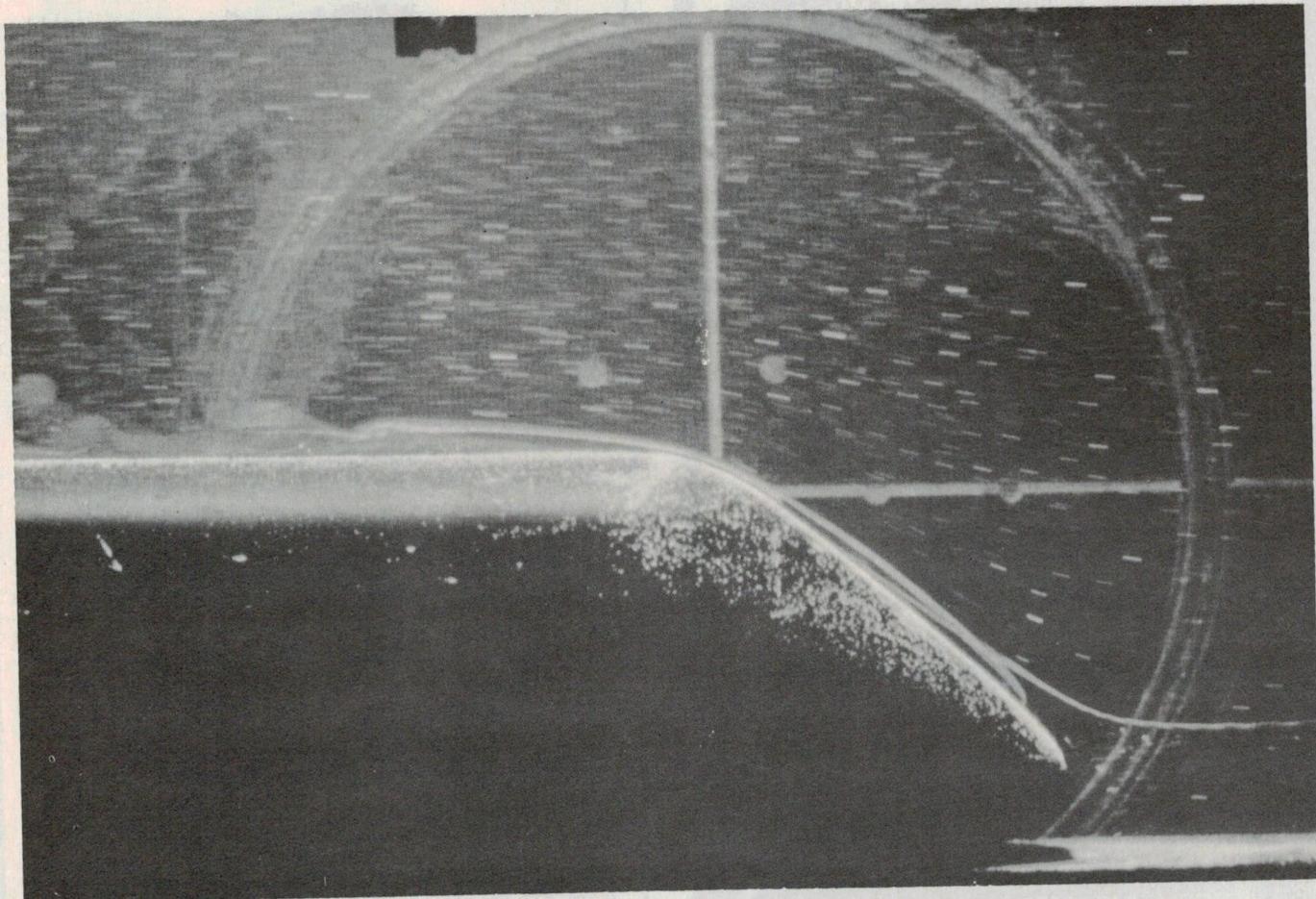
A report is now being prepared on the economics of MAGLEV by the Canadian Institute of Guided Ground Transport under the sponsorship of the



An outdoor view of the NRC-DME model, showing the deployed outrigger wheels and luggage compartments. (Photo: Pat Griechen, DME Canada.)

federal Ministry Transport Canada. The study group wants to know if the capital outlay to create a system operating in the Montreal-Ottawa-Toronto corridor will ultimately be offset by the revenue generated by passengers and freight anticipated over the short-haul route. "Our conceptual

design study reflects some serious changes of attitude," concludes Hayes. "Where MAGLEV was initially an idea for high-speed inter-city commuter convenience, it now promises to provide high capacity transportation without seriously infringing on non-renewable energy supplies." •

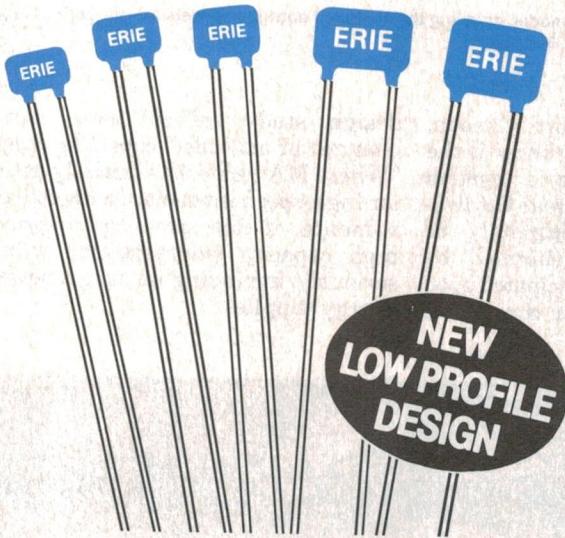


Another model of the MAGLEV undergoes aerodynamic testing at NRC's National Aeronautical Establishment testing facilities. Vehicle nose shape is critical at speeds up to 500 km/h. (Photo: George Dobrodzicki, DME Canada.)

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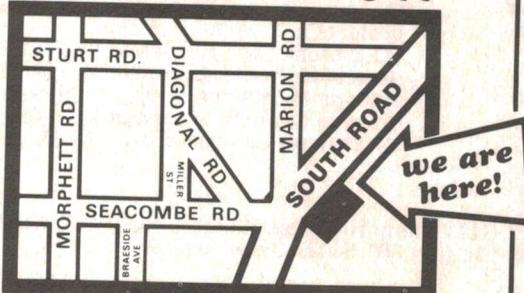
Contact Mike Rogers, Kit Centre Manager  
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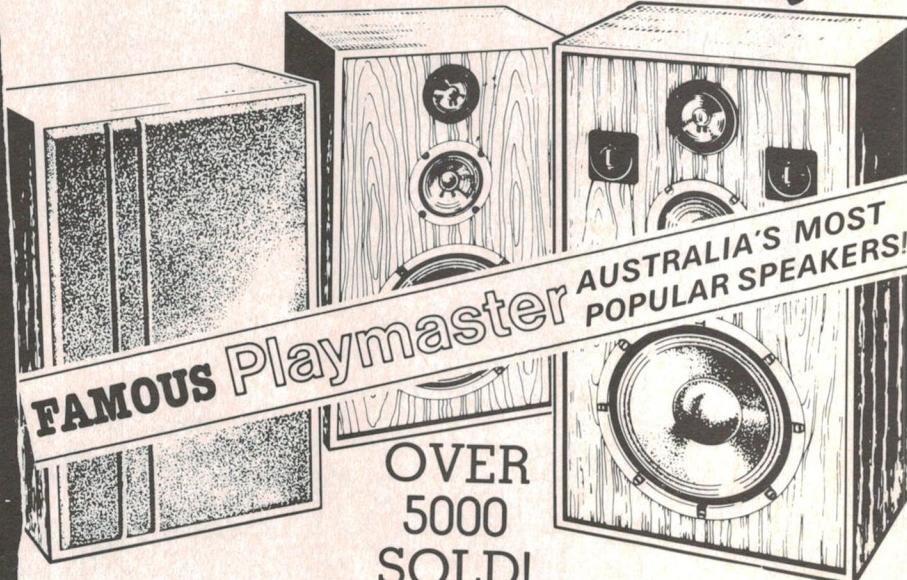
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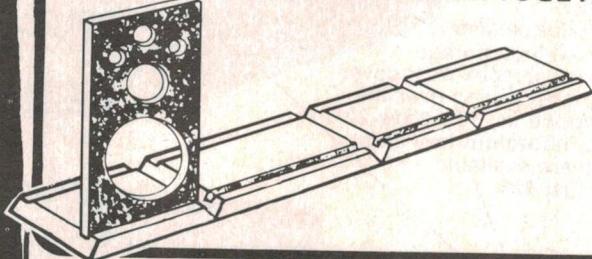
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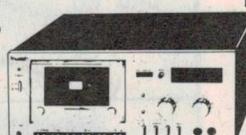
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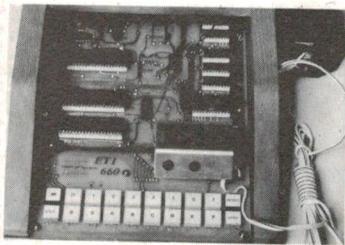
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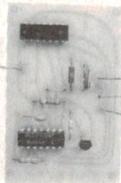
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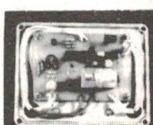
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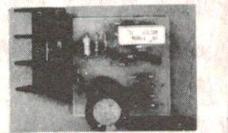
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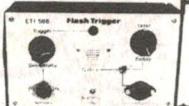
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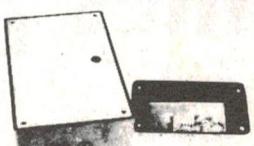
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## A learners' microcomputer

With this installment the construction of the project is completed in stages, taking you right through to full colour operation and full on-board memory. As before, the project can be checked at each stage.

**Design: Hugh Anderson**

**Development: Graeme Teesdale**

**Part 4**

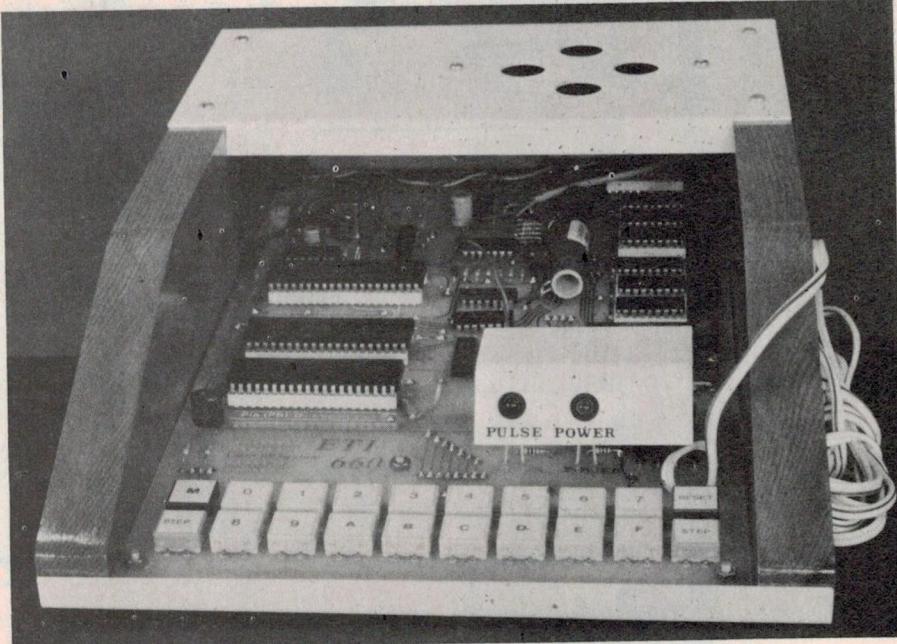
HAVING got the power supply running and checked that all is well with the board so far, you are now ready to assemble the unit for monochrome operation with the minimum amount of memory (1K).

First of all, remove the 8 Vac input power lead that you temporarily attached to test the first stage of construction. Sort out and solder in place the following resistors, as shown in overlay drawing 3:

R1	220R
R2	120k
R3	47k
R7	3k3
R10	1k2
R11	10k
R20,21,22	390R
R23	15k
R24	1k2
R25	8k2
R26	180R
R27	120k
R28	22k
R30	120k
R31	1M
R32	22k
R33	1M
R34	180k

Note that some of the resistor leads have to be soldered both sides of the board, so inspect each resistor position as you proceed and make sure you solder each lead appropriately. The easiest way to accomplish the task is to insert the resistors one at a time, solder each lead and then cut off the excess lead. This way you're less likely to miss soldering the occasional pad and lead.

Next, tackle the remaining capacitors. Sort them out, identify where they go and solder them in place one by one, cutting the leads as you go. Refer to



The completed project mounted in the simple case we made up for it.

overlay drawing 3, also. Here they are:

C3	100n greencap
C4	10n greencap or ceramic
C5	3-30p trimmer
C7	470p ceramic
C8	100n greencap

Note that the trimmer, C5, may come in a variety of packages. Some are quite small and only have two pins. It doesn't matter which way around they go but note that there are only two 'correct' pads. Other types (particularly the Philips and Stetna types) have three pins and may be 7 or 8 mm in diameter. They will only fit on the board one way. There are three pads, so inspect how it goes in before you mount it on the board.

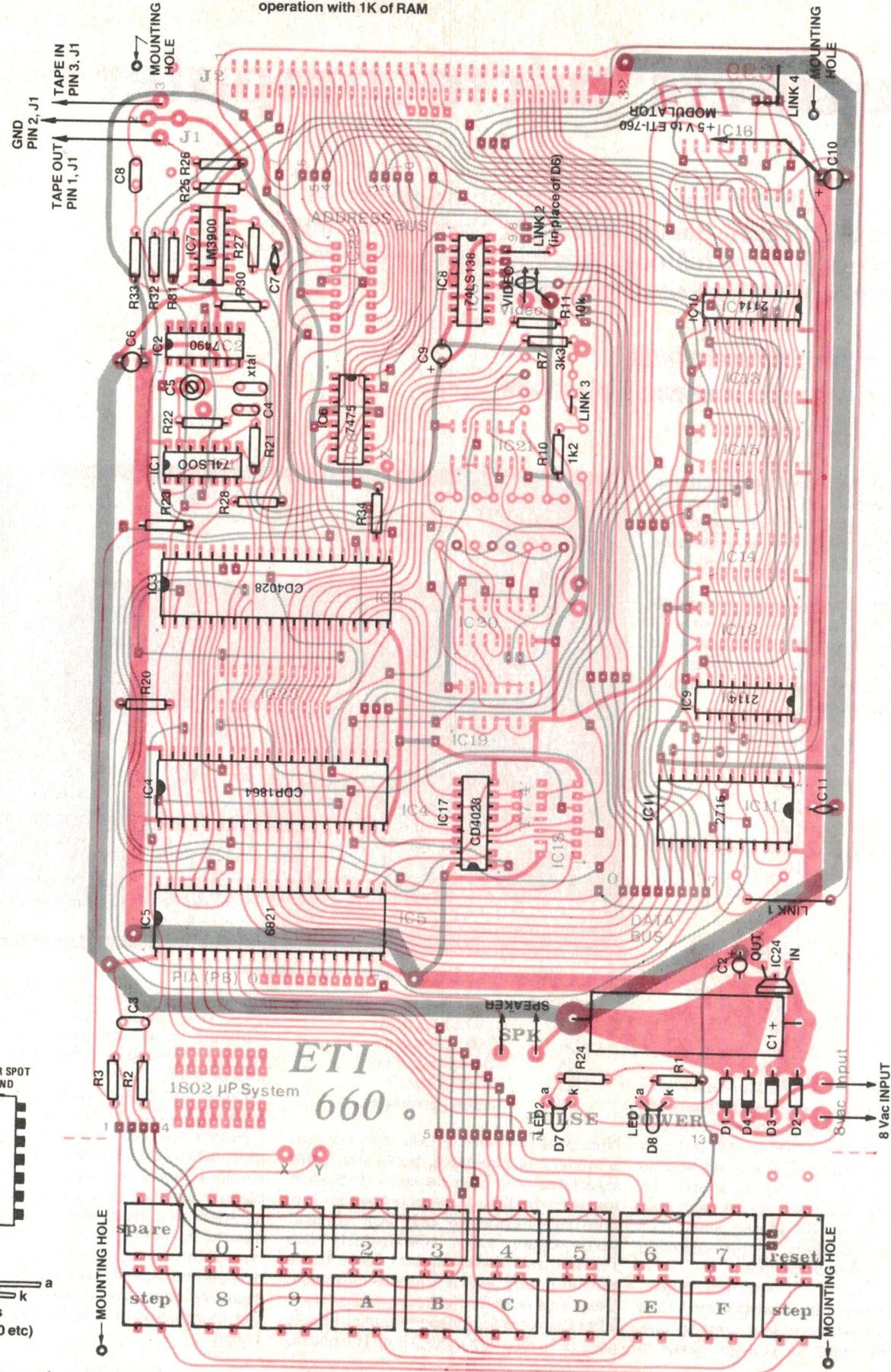
The trimmer is located between IC1 and IC2. We should mention that the trimmer value and range are not too critical. A 5-40p or 8-60p may equally well be used.

Capacitor C7 has one lead soldered on both sides of the board, note.

Solder the 8.867238 MHz crystal in place next. It doesn't matter which way round it goes, but solder quickly and cleanly to avoid overheating the device as excessive heat may damage it. It should be mounted fairly close to the board, but make sure the base sits two or three millimetres above the top of the board to avoid the crystal's case shorting to adjacent tracks on the top of the board.

# Project 660

OVERLAY DRAWING #3  
Components for monochrome  
operation with 1K of RAM



NOTCH OR SPOT  
AT THIS END



ICs



## Keyboard

There are several options for the keyboard. As stated earlier in this series, you can opt for a standard hex keypad and add pushbuttons for the STEP and RESET buttons or you can use our design, which employs Fujitsu keyswitches (type FES-310) mounted on the main pc board in two rows.

If you are using a standard hex keypad plus pushbuttons for the STEP



A hex keypad may be used instead of our keyboard. These will have eight pins on the rear marked '1' to '8', which are connected as shown in the accompanying drawing.

and RESET then the pc board may be foreshortened if you wish. On the underside of the board you will notice a short, dashed line adjacent to the 8 Vac input pads. On the opposite edge of the board is another dashed line. A straight cut between these two dashed lines will part our keyboard section from the main board. Your hex keypad then connects directly to the row of pads in the middle of the board — one outer pad is marked '5' and the other '12' on the top of the board.

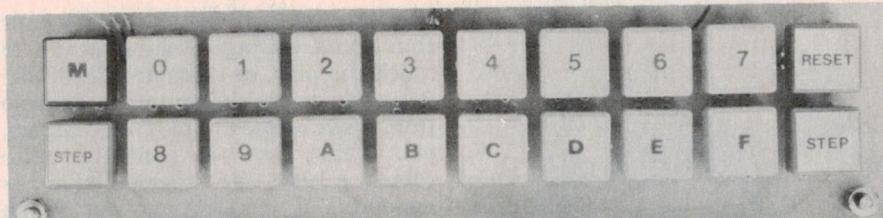
The RESET pushbutton connects to the two pads marked '1' and '4' on the top of the board, while the STEP pushbutton connects to the two pads between these. Link the pad marked '4' to the pad marked '13' with a length of insulated hookup wire.

If you have elected to go with our design of keyboard then the FES-310 keyswitches can be inserted in the board and soldered in place. Note that you can leave out the SPARE key and one of the STEP keys if you wish, in which case only 18 keys are required.

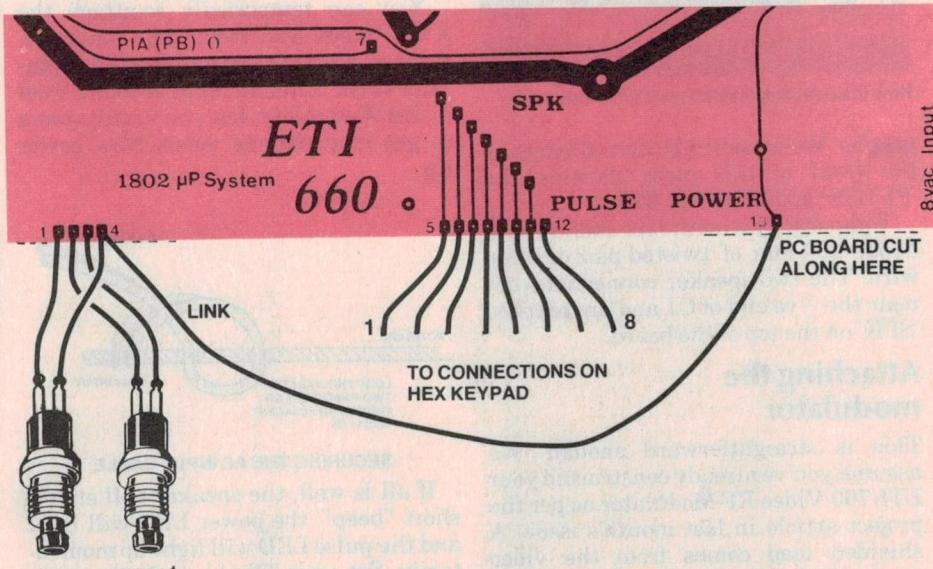
The Fujitsu keyswitches have no markings on them. We made up some small Scotchcal labels and stuck them on the keys after they were soldered in the board.

## Links

There are four links to install. One is adjacent to IC11 (LINK 1); another is



The FES-310 keyswitches we used have Scotchcal labels stuck on them to indicate which key is which.



### HOW TO CONNECT A STANDARD HEX KEYPAD AND 'STEP' & 'RESET' PUSHBUTTONS

adjacent to IC8 (LINK 2), right near the video output pads. LINK 3 is between R7 and R10 and LINK 4 is adjacent to the position of IC16. With the latter, note there are three feedthrough links between IC16 and the adjacent mounting hole — join them together and bridge them to the 0 V track that runs nearby. You should be able to see this link clearly on overlay drawing 3. Use insulated hookup wire for LINK 1, 22g tinned copper wire for the other three.

## ICs

The non-socketed ICs may be assembled to the board next. These are:

IC1	74LS00
IC2	7490
IC6	7475
IC7	LM3900
IC8	74LS138
IC17	4028

Watch their orientation. This should be clear from overlay drawing 3 but don't forget that the top side of the board has a small spot adjacent to pin 1 of each IC. No excuses if you get one in back to front!

Take care that you don't bend any pins under the IC package and that you solder all pins. Watch for solder 'bridges', as we've warned you earlier.

Apart from that, no special care need be taken with these ICs.

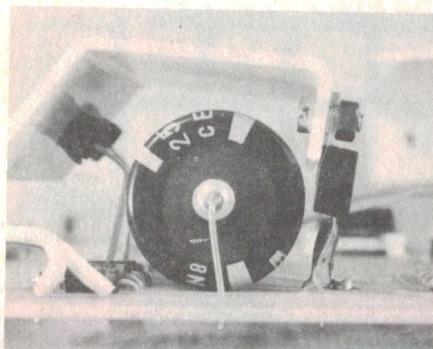
If you're *not* using sockets, solder ICs 3, 4, 5, 9, 10 and 17 in place too. You should use a socket for IC11, as this IC may be changed or reprogrammed later.

Now you can solder LED2 (D7) in place. Mount it so that it stands the same height as does LED1.

Take a pair of long-nose pliers and grip one of the LEDs by the leads about 5 or 6 mm back from the bottom of the head. Bend it away from C1 so that the head faces the keyswitches at about 60° to the vertical. Do the same with the other LED.

At this stage, if you don't have, or have not made, the heatsink bracket for IC24 — do it now. This is a small piece of aluminium, 60 mm square, drilled and bent up as per the drawings available from us, or in your kit. There is a hole near one corner, on the part bent down at 90°, to which the metal flange of IC24 is bolted, and two holes on the angled section in which LED-mounting clips are inserted to accommodate the two LEDs. It is easiest to assemble if you carefully insert the two LEDs first, and then bolt it to the tab on IC24. Note that IC24 bolts on the *outside*. This simple little assembly is visible in the photo-

# Project 660



How the heatsink bracket for IC24 is mounted.

graphs. We attached Scotchcal labels to the front of this plate showing the 'PULSE' and 'POWER' LEDs.

Temporarily wire the speaker up with about 200 mm of twisted-pair hookup wire. The two speaker connections are near the -ve end of C1 and are marked 'SPK' on the top of the board.

## Attaching the modulator

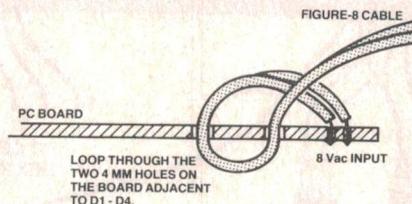
This is straightforward enough. We assume you've already constructed your ETI-760 Video RF Modulator as per the project article in last month's issue. A shielded lead comes from the video input of the 760 modulator and this should be attached to the pads on the board adjacent to IC8 marked 'Video'. Cut the lead to a length of about 250 - 300 mm — longer if you like, but not any shorter. The shield braid need only be soldered on the top side of the board; the inner conductor solders to the adjacent pad on the underside of the board.

The power supply connection to the modulator comes next. Cut this about 50 or 100 mm longer than the video lead. It solders to the positive (+) lead of capacitor C10, on the top of the board. You can locate this capacitor on overlay drawing 3; it's adjacent to the position of IC16 (not in place at this stage), near one of the mounting holes.

Now you're almost ready for the big switch on! But before you do, run over everything you've done once more and make sure there are no tracks bridged, leads left unsoldered or components missing. Check your board against overlay drawing 3. If all is well, you can plug in IC3 (1802), IC4 (1864), IC5 (6821), IC9 and IC10 (2114) and IC11 (2716 or 2516) — we're assuming you've used IC sockets for these chips as recommended and that you have your EPROM (IC11) already programmed. Make sure you plug these ICs in the right way round and that no pins get folded under the package. Handle the

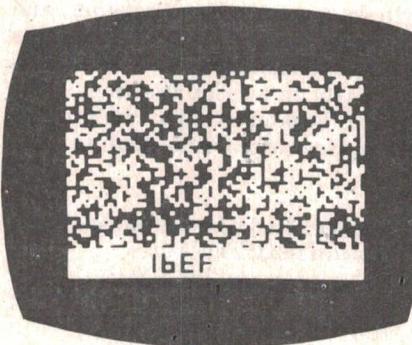
packages by the ends using only your thumb and forefinger, taking care not to touch the pins, as these are CMOS devices which are susceptible to damage from static created by clothing, carpets, etc. Whilst they are generally quite robust, a little care prevents later disappointment, frustration and harsh words unfairly voiced about the origins of certain component suppliers.

You can temporarily re-attach the 8 Vac input lead from your plugpack. Connect the RF output of the 760 modulator to the antenna input of your TV set — B&W or colour, but you're only going to get monochrome video. Now power up.



### SECURING THE AC INPUT CABLE

If all is well, the speaker will emit a short "beep", the power LED will light and the pulse LED will light up momentarily. Set your TV channel selector to channel 1 (or switch across channels 1, 2 and 3 until you get a picture). Adjust the trimmer in the 760 modulator for a good signal. You may need to adjust the controls on the TV to get a sensible picture on the screen. When it 'locks in' you should see something like this:



Press RESET if you have a stable picture but it doesn't make sense, and then you should get something like the above. Press RESET (again, or for the first time) and you will see the screen go blank momentarily, the speaker will emit a short 'beep', the pulse LED will light briefly and the screen will come back with the same picture. The random pattern you see in the top portion of the picture is just what happens to be in the video display memory. The bar at the

bottom contains a four-digit number which is a little to the left of centre. This is a hex representation of a memory location.

Now that it makes sense, try this:

press 'RESET'

press '8'

This will get rid of the random pattern above the solid bar. If it leaves a few bits above the bar press RESET again or turn the power off briefly, then on again and repeat 'RESET' '8'.



Now,

press '0'

press '0480'

press 'STEP'

The screen will now show '0480 00' in the bar at the bottom of the screen. Now press 'FF'.

The screen will now show a short horizontal line at the top left hand corner of the screen and the bar at the bottom will show '0480 FF'.

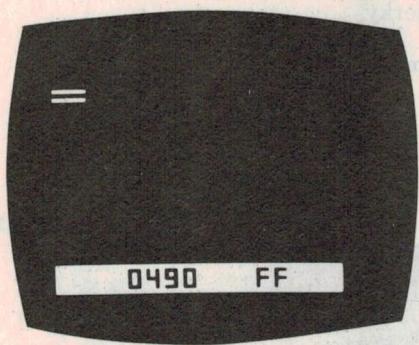


You will notice that when you press a key the speaker will emit a beep and the pulse LED will flash — but not when you press the STEP key. The keys at the 0, 1, 2, 3 end of the keyboard are accompanied by a short 'pip' when pressed, those at the D, E, F end of the board by a longer 'beep'. The beep that signifies you've pressed the RESET key is much the same length as the one that sounds when you press F.

Now try this:

press 'RESET'  
 press '0'  
 press '0490'  
 press 'STEP'  
 press 'FF'

The screen will show '=' at the top left-hand corner and '0490 FF' in the bar at the bottom.



What you are doing is looking at the video display memory and entering data into it which are then displayed.

Now try this one: turn the power off briefly, then on again. This will bring up the original pattern with random dots and the bar at the bottom showing a strange four-digit number

press 'RESET'  
 press '0'  
 press '0600'  
 press 'STEP'  
 press '00'  
 press 'STEP'  
 press 'FC'  
 press 'STEP'  
 press 'RESET'  
 press '6'

The screen will now go blank!

Press RESET to return the display. Now you're ready to put the thing in its box, or whatever you're going to house it in, if you're not going any further with construction (be assured, this will only be temporary because once you've been bitten by the bug you'll always want to do more!). Next thing is to try your hand at programming — see 'Programming in CHIP-8 — a crash course' elsewhere in this issue.

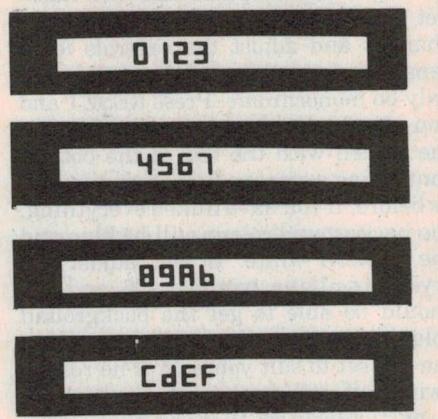
## Adding colour

Having got your 660 up and running in monochrome you can add the components necessary for colour operation. Firstly, you're going to have to remove all those external connections — the 8 Vac input lead, the speaker leads and the connections to the 760 modulator (video and +5 V supply). Also, remove LINK 2 between R7 and R10 and LINK 4 adjacent to IC16.

You will need an additional 16 re-

## LETTERS AND NUMBERS

The letters and numerals that make up the hexadecimally indicated displays on the TV screen from the ETI-660 microcomputer are fairly basic in construction, and it's handy to get to know what you're looking at to avoid confusion. They are of seven-segment construction, so the numerals 0 to 9 will look familiar as they're much like those on a seven-segment LED display — the '6' has a tail across the top and the '9' has a tail across the bottom. Of the letters A to F, 'B' and 'D' appear sort of lower case. Don't confuse 'b' for a '6'. The accompanying four pictures show the complete set in order from 0 to F.



sitors, three of which substitute for resistors originally used for monochrome operation. Those marked on the parts list with an asterisk (\*) are only used for colour operation, those marked with a double asterisk (\*\*) change when adding the colour option. Sort out the following resistors and solder them in place according to overlay number 4:

R4	4k7
R5	1k
R6	4k7
R8	680R
R9	68R
R12	5k6
R13	1k2
R14	1k5
R15	2k7
R16, R17	2k2
R18	1k2
R19	4k7

Change:

R7 to 2k2  
 R10 to 470R  
 R11 to 5k6

Note that R5 has one lead soldered on both sides of the board.

Next, solder the 400 ns delay line to the board. This device will have three leads. One is an 'earth' lead. This solders to a section of the 0 V track which runs on the topside of the board from the video output connection to near IC20. The pad is located adjacent to R8. Location and orientation of the delay line on the board should be clear from overlay drawing 4.

If you have been unable to obtain a delay line then the 660 may be operated in the colour mode without it with meaningful, if not acceptable, results.

Simply link the two pads that connect the 'input' and 'output' ends of the delay line — the pad that connects to the junction of R4, R5, R6, and R7 and one end of R8. Use a length of insulated hookup wire to do this. You can replace this with the delay line at a later date.

Last of all, the ICs may be assembled to the board. Note that we used a socket with IC16. Just as an aside, this IC may be any of a number of equivalent types; the 2101 is now superseded but it may be replaced directly by either a 5101 or a CDP 1822. We did not use sockets on the other ICs used in the colour encoder portion of the circuitry. Sort out and solder in place these ICs, then:

IC18	74LS00
IC19	74LS86
IC20	74LS00
IC21	4066

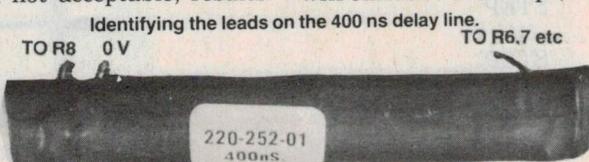
Take care that you orient each IC correctly as you insert it. IC16 and IC21 are CMOS types and you should only handle the packages by their ends, using your thumb and forefinger, to insert them. During soldering, take care once again not to get solder bridges between tracks and that you don't have any dry joints.

Once again, having completed this phase of construction, check everything you've done, especially IC orientation.

## Get ready!

Now you can attach the 760 modulator, the loudspeaker and the 8 Vac input lead again. Connect the RF output of your 760 modulator to the antenna input of your colour TV set. Now power up.

As before, if all is well the speaker will emit a short "beep", the power LED



# Project 660

will light and the pulse LED will flash. Set your TV receiver to the appropriate channel and adjust the controls for a sensible picture. At this stage it may only be monochrome. Press RESET and you should get the random pattern on the screen with the bar at the bottom containing a strange four-digit number, as before. If you have fluked everything, the background colour will be blue and the pattern white. If not, adjust the crystal oscillator trimmer, C5, and you should be able to get the background colour to 'pop in'. Adjust the controls on the TV set to suit yourself. If no result, switch off and check your construction — particularly see that you have all the resistors for colour operation correctly placed and soldered.

Now you can go through the same checking procedure as for monochrome — this time the display will be in blue and white!

## Colour check

Here is a simple series of tests to demonstrate/check-out the colour operation. Turn off the power briefly, then on again. You should get the random dot display (in white) with the bar at the bottom showing '1bEF' on a blue background. Press RESET if you don't and it should appear. Then,

press      '0'  
              '07B0'  
              'STEP'  
              'E9'  
              'STEP'  
              '61'  
              'STEP'  
              'D4'  
              'STEP'  
              'RESET'  
              '0'  
              '0600'  
              'STEP'  
              '07'  
              'STEP'  
              'B0'  
              'STEP'  
              '07'  
              'STEP'  
              'B0'  
              'STEP'  
              '07'  
              'STEP'  
              'B0'  
              'STEP'  
              '07'  
              'STEP'  
              'B0'  
              'STEP'  
              '16'  
              'STEP'

At this point the four-digit number in the bar at the bottom of the screen should show '0609'. If it doesn't you're

going to have to press RESET and start over again. If it shows '0609' then proceed with:

'02'  
'RESET'  
'8'

The screen will come to life with a 'licorice allsorts' pattern with a series of stripes at the top and bottom of the screen and a broad band in the centre stepping rapidly through BLUE-BLACK-GREEN-RED continuously while the stripes at the top and bottom seem to 'roll down' the screen.

You can try a variation on that by altering the program, as follows:

press      'RESET'

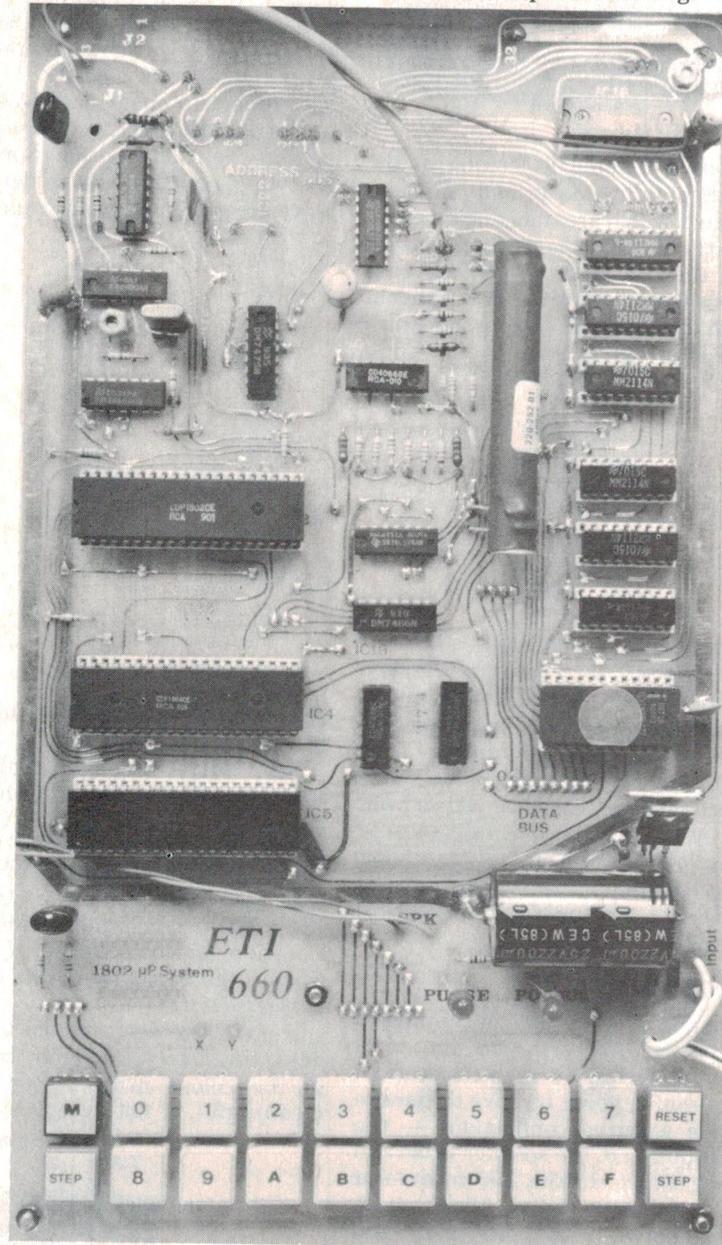
(this will stop the mesmeric action on-screen)

press      '0'  
              '0609'  
              '04'  
              'RESET'  
              '8'

The licorice allsorts pattern will appear again, only this time BLUE and GREEN will stay on-screen longer than RED and BLACK and the stepping through of the colours becomes a little 'jerky'.

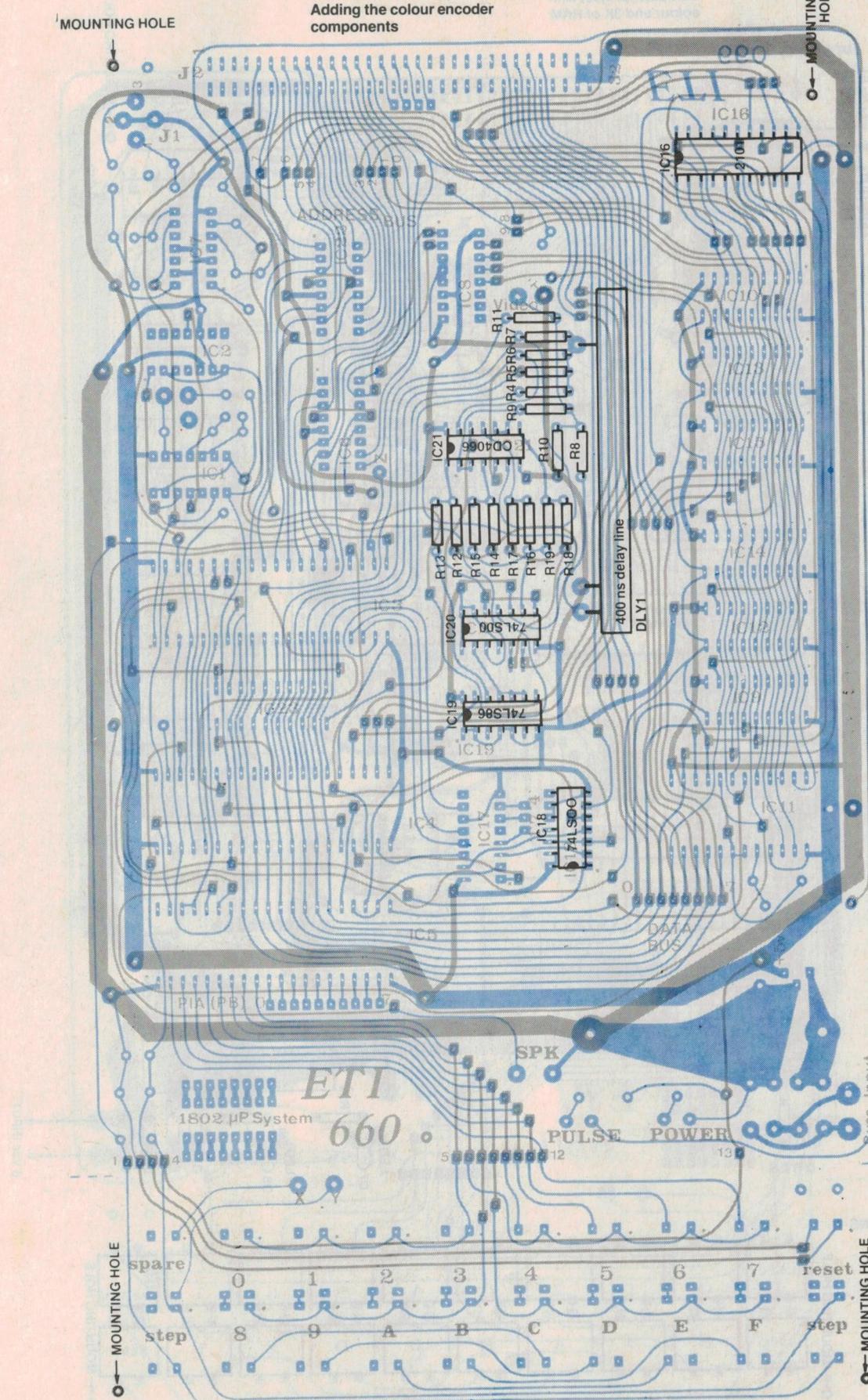
Now try this:  
press      'RESET'  
              '0'  
              '0609'  
              '06'  
              'RESET'  
              '8'

The effect is quite sickening! ▶



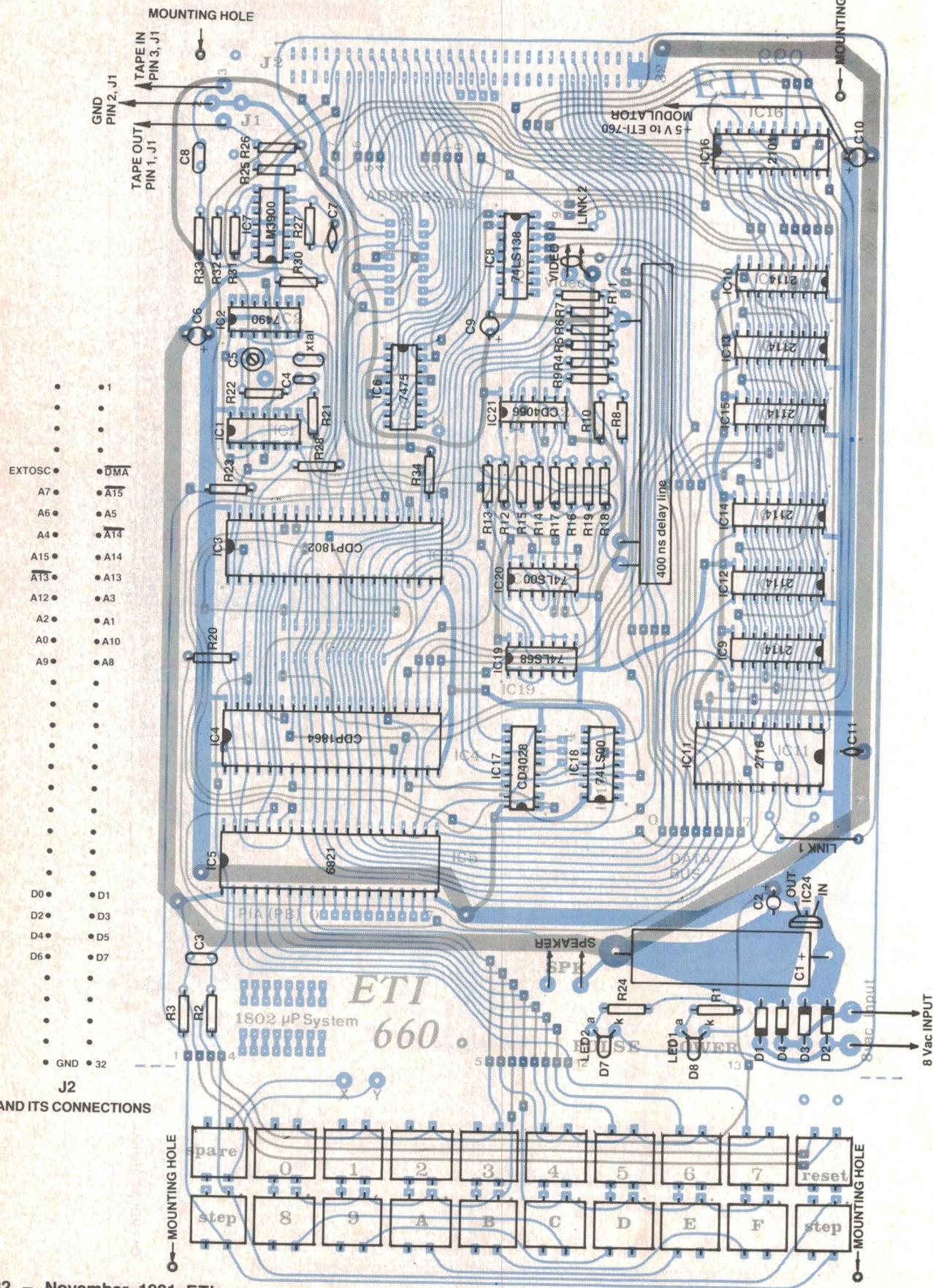
The completed board with colour and 3K RAM.

OVERLAY DRAWING #4  
Adding the colour encoder  
components



# Project 660

OVERLAY DRAWING #5  
Complete project with  
colour and 3K of RAM



## THE CHIP-8 MONITOR PROGRAM

So that your ETI-660 microcomputer will behave in a predictable, logical way when you press a simple sequence of keys on the keyboard, a program is permanently stored in a Programmable Read-Only Memory, or PROM — which is IC11 on the pc board, a 2716 or 2516. You cannot alter any part of the program in this memory by any operation of your ETI-660.

The information, or program, stored in IC11 is interpreted by the 1802 microprocessor as a series of 'instructions'. The program causes the 1802 (IC3) to activate IC5, the MM6821 Peripheral Interface Adaptor (PIA), which 'reads' instructions entered via the keyboard, for example. It also causes the 1802 to activate the CDP1864, which provides video and audio outputs. In essence, it controls the basic functional operation of the 1802 microprocessor so that it does a specific task in a specific way in response to a simple instruction from the keyboard.

Following is a listing, in hexadecimal code, of the monitor program residing in the PROM, IC11. Whilst the listing shown commences at location 3000, running to 33FF, it actually has to reside in the PROM from location 0000 to 03FF. Kit and component suppliers may supply the PROM already programmed. If you're obtaining your components individually then you'll need to find a firm that will program your PROM for you.

Whilst the PROM has a capacity of 2Kbytes, this program only occupies the 'lower' 1K. The 'upper' 1K is 'empty' and may be programmed with some other set of instructions at a later date.

3000 F8 04 B2 B6 F6 B4 F6 E1	3220 8C FC 0F AC 0C A3 D3 30
3008 F6 B5 A4 F8 38 A1 A2 F6	3228 00 0F B3 45 30 25 45 56
3010 A5 F8 0F 52 E2 62 F8 20	3230 D4 03 03 03 03 03 02 00
3018 52 62 A8 D4 20 4E F0 0A	3238 03 03 02 03 02 02 00 03
3020 00 FC B0 3A 20 4E F0 0A	3240 DB 7C 75 9E A8 B2 2E F3
3028 00 88 78 10 00 BD 20 62	3248 81 AE 50 B6 55 60 AA 05
3030 F0 A0 10 4A 01 BC 20 6E	3250 45 AA 86 BA D4 E9 99 F4
3038 10 2A 10 24 01 8B 01 60	3258 E6 F4 B9 56 45 F2 56 D4
3040 02 40 00 E0 00 F8 26 00	3260 06 BE FA 3F F6 F6 F6 22
3048 00 00 00 72 10 36 02 EB	3268 52 07 FE FE FE FE F1 AC 96
3050 00 F8 68 10 69 2A 00 BF	3270 7C 00 BC 8C FC 80 AC 9C
3058 20 62 78 04 00 BD 20 62	3278 7C 00 BC 45 FA 0F AD A7
3060 00 EE F1 29 D8 95 78 04	3280 9C FF 06 32 DB F8 50 A6
3068 F0 29 D8 95 00 EE 02 F2	3288 F8 00 RF 87 32 E2 27 4R
3070 10 52 0B FE FE FE FE 5B	3290 BD 9E FA 07 AE 8E 32 A1
3078 EB 8D F4 5B D4 FF EF D3	3298 9D F6 BD 8F 76 AF 2E 30
3080 8B FB AB 9B 7E BB 30 7E	32A0 95 9D 56 16 8F 56 16 30
3088 96 BF AF F8 80 BE FE F8	32A8 88 EC EC F8 50 A6 F8 00
3090 24 A5 DE DE DE DE 5F 1F	32B0 A7 8D 32 DB 06 F2 2D 32
3098 8B 5F 8D F4 5F D4 42 30	32B8 9B 91 A7 46 F3 5C 02 FB
30A0 R7 42 32 A6 15 15 D4 32	32C0 07 32 CE 1C 06 F2 32 CA
30A8 A4 12 22 F8 03 BC F8 CB	32C8 91 A7 06 F3 5C 2C 16 8C
30B0 AC 06 FA 0F FC 01 52 DC	32D0 FC 08 AC 9C 7C 00 BA FF
30B8 E2 F5 52 45 A3 8B 38 9B	32D8 06 3A B1 F8 7F A6 87 56
30C0 22 52 96 BE F8 70 AE 42	32E0 12 D4 8D A7 87 32 R9 2A
30C8 5E 1E F6 F6 F6 5E D4	32E8 27 30 E4 96 BF AF 4F BB
30D0 1B 4B 32 DC FF 31 32 D0	32F0 0F AB F8 05 BF F8 C8 AF
30D8 FF 01 3R D1 D4 0B 30 C0	32F8 F8 FF 5F 1F 8F 3A F8 D4
30E0 96 BF F8 80 AF 93 5F 1F	3300 22 06 52 64 D4 45 A3 98
30E8 FF 0F 06 3R E5 D4 42 B5	3308 56 D4 93 BC F8 CB AC DC
30F0 42 A5 D4 45 E6 F4 56 D4	3310 3A 0F DC 30 F7 06 B8 D4
30F8 22 69 12 D4 22 6C 12 D4	3318 06 A8 D4 64 0A 01 E6 8A
3100 18 1D 28 30 1A 26 2A 1C	3320 F4 AA 3B 28 9A FC 01 BA
3108 2C 2E 16 14 12 20 24 10	3328 D4 91 B6 0F BA FF AA 0A
3110 E0 80 E0 80 80 80 E0 R0	3330 AA D4 FF E6 06 BF 93 BE
3118 E0 A0 A0 A0 E0 20 20 20	3338 F8 1B AE 2A 1A F8 00 5A
3120 20 20 E0 A0 E0 80 E0 80	3340 0E F5 3B 4B 56 0A FC 01
3128 E0 20 E0 80 E0 A0 E0 A0	3348 5A 30 40 4E F6 3B 3C 9F
3130 E0 20 E0 20 E0 7A 42 70	3350 56 2A 2R D4 FF 22 86 52
3138 22 78 22 52 C4 19 F8 80	3358 F8 70 A7 07 5A 87 F3 17
3140 A0 96 B0 E2 80 E2 E2	3360 1A 3A 5B 12 D4 22 86 52
3148 20 A0 E2 20 A0 E2 20 A0	3368 F8 70 A7 0A 57 87 F3 17
3150 3C 45 98 32 59 A0 20 80	3370 1A 3A 6B 12 D4 15 85 22
3158 B8 88 32 35 7B 28 30 36	3378 73 95 52 25 45 A5 86 B5
3160 F8 E2 A1 F8 D4 D1 81 BD	3380 D4 45 FA 0F 3R 89 07 56
3168 D7 3B 66 9D 3A 68 D7 33	3388 D4 AF 22 F8 D3 73 8F F9
3170 6E 93 BD AD 17 9D 7E BD	3390 F0 52 E6 07 D2 56 F8 7F
3178 3B 74 D7 8D F6 33 FE 9D	3398 A6 F8 00 7E 56 D4 45 E6
3180 5E 8E D1 1E 2C 9C 3A 6E	33A0 F3 3A R7 3F A3 15 15 D4
3188 C0 00 00 F8 E2 A1 F8 BF	33A8 45 E6 F3 3A R5 D4 45 07
3190 D1 F8 E0 BD FF 00 D7 9D	33B0 30 R9 45 07 30 9E F8 70
3198 3A 94 8E D1 7B 4E BB FC	33B8 A7 E7 45 F4 R5 86 FR 0F
31A0 00 F8 09 AB AD 17 2B 8B	33C0 3B C4 FC 01 B5 D4 2D 2D
31A8 32 AF 9B FE BB 30 A5 8D	33C8 2D 8D D3 96 BF BE F8 4C
31B0 F6 D7 2C 9C 3A 9A D7 D7	33D0 AF F8 48 AE F8 10 AD F8
31B8 D7 30 88 FF 1B D4 D3 7B	33D8 F7 BD 5E EE 62 2E EF 6A
31C0 F8 38 3B C7 F8 00 1D 52	33E0 FE 3B C9 FE 3B C8 FE 3B
31C8 FF 01 33 C8 39 BE 7A 02	33E8 C7 FE 3B C6 2D 2D 2D 2D
31D0 30 C8 1D D3 F8 17 35 D6	33F0 9D F6 BD 33 DA 30 C9 2F
31D8 35 D2 FF 01 33 D8 3D DE	33F8 A3 32 12 A8 2D 8D 56 D4
31E0 30 D3 A7 91 B7 96 BD 95	
31E8 AD 4D BE 4D AE 1D ED F5	
31F0 AC 2D 9E 75 FC 01 BC E2	
31F8 D3 22 52 64 30 F8 7B 00	
3200 96 B7 E2 94 BC 45 AF F6	
3208 F6 F6 32 29 F9 30 AC	
3210 8F FA 0F F9 70 A6 05 F6	
3218 F6 F6 F6 F9 70 A7 4C B3	

### NOTE:

There were several small errors in the Parts List published last month.

\*R11 ... 10K (5K6 for colour)

R12 ... 5K6

Note the changes for R11 and R12, IC19 is a 74LS86 (not a 74LS68) and a total of 20 (not 18) FES-310 pushbuttons are specified.

## All OK?

If all is operating well at this stage, then you're ready to start learning to make use of your computer. Turn to 'Programming in CHIP-8 — a crash course' elsewhere in this issue.

## More memory

So far we have only described construction with the minimum amount of memory (1K). There is provision for up to 3K of memory to be available on-board and adding it is very simple.

You can add more memory in stages, as your money permits, or you can take the memory up to 3K in one go. If you have used sockets as we recommended then all you need to do to add another 1K of memory is buy another two 2114 RAM ICs. These should be inserted in the positions shown for IC12 and IC13. Note that IC12 is adjacent to IC9 and IC13 is adjacent to IC10. Refer to overlay drawing 5, which shows the completed 660 with all current options on-board. To add the last 1K of memory, two more 2114 ICs are required and these go in the positions shown for IC14 and IC15 on overlay drawing 5.

If you are soldering these in place, once again, take care that you don't get any solder bridges between pins or dry joints, and take particular care with the orientation.

— continues page 43. ▶

## ACKNOWLEDGEMENTS

This project would not have come to fruition had it not been for the efforts of three New Zealanders. Jim Coyle of (at that time) Kit Parts NZ, had a new kit in his inventory which he thought (a) should enjoy a wider currency and (b) could benefit from the 'ETI treatment'. We bought the idea(s). That original unit was known as the 'HUG 1802' — after the man who developed it for Kit Parts, Hugh Anderson, and the microprocessor employed — the 1802.

Hugh Anderson is New Zealand's answer to Leonardo da Vinci — electronically speaking. Like Leonardo, Hugh is more concerned with execution of a never-ending succession of brilliant ideas than the general dissemination of same. Jim Coyle was to Hugh what the Medicis were to Leonardo.

Between the time we arranged to give the project the 'ETI Treatment' and when we came to ponder just who was to undertake the exercise, one Graeme Teesdale — an electronics lecturer and hobbyist extraordinaire from Hamilton N.Z. — requested the opportunity to spend his 1981 sabbatical working at ETI. He said his forte was microprocessors and that it wouldn't cost us anything.

That clinched it!

During three months early in 1981 Graeme tackled the monumental task with gusto and this finely wrought machine is the result — after encountering a succession of difficulties which he managed to surmount. May the bags under his eyes grow ever less!

Roger Harrison  
Editor ETI.

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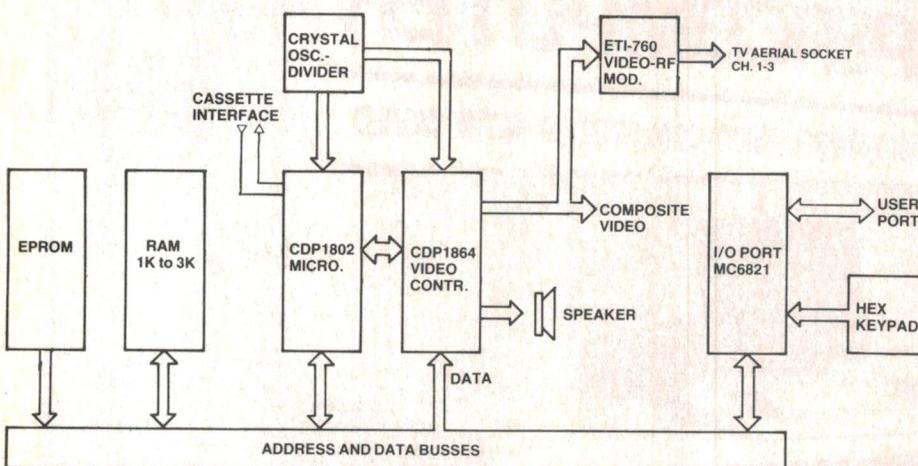
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# Project 660



OVERALL BLOCK DIAGRAM

## HOW IT WORKS — ETI 660

The accompanying block diagram shows the overall arrangement of this microcomputer. The 1802 (IC3) microprocessor performs tasks according to instructions from a program, entered by the user, under the control of a 'monitor' program resident in EPROM (IC11 — a 2516 or 2716). The user's program is stored during operation in Random Access Memory — RAM — on board (ICs 9 and 10 for 1K of memory, ICs 12 to 15 take it to a total of 3K). Programs are entered using a simple hexadecimal (base 16 number system) keyboard via a Peripheral Interface Adaptor — or PIA — IC5 (MC6821). This provides interfacing to the real world via input/output (I/O) 'ports' (control lines) enabling the user to get 'into' the computer to operate it and get signal 'out' of it to control peripheral equipment that may be attached (e.g. printer, sound synthesiser, etc.).

To communicate to the user what's happening with the microprocessor a Video Controller chip (IC4, a CDP1864) generates the appropriate synchronisation and composite video signals, which can be connected directly to a video monitor or to a TV set via a Video RF Modulator (Project ETI-760, Oct. '81) to provide a video display. This chip also generates an audio output which drives a speaker, providing up to 256 programmable tones. Monochrome or colour video signals are obtained by combining the appropriate video controller outputs in suitable external circuitry.

To 'clock' the operation of the microprocessor and video controller a crystal oscillator and divider chain generates the appropriate frequencies from a single crystal of a suitable frequency (8.867238 MHz).

A cassette interface is simply provided direct from the microprocessor, the signals being suitably modified by two op-amps.

Power supply is straightforward. All the circuitry runs from a single 5 V rail derived from a bridge rectifier powered by an ac output plugpack.

Following is a general explanation of how the devices in each portion of the circuit carry out their functions.

### POWER SUPPLY

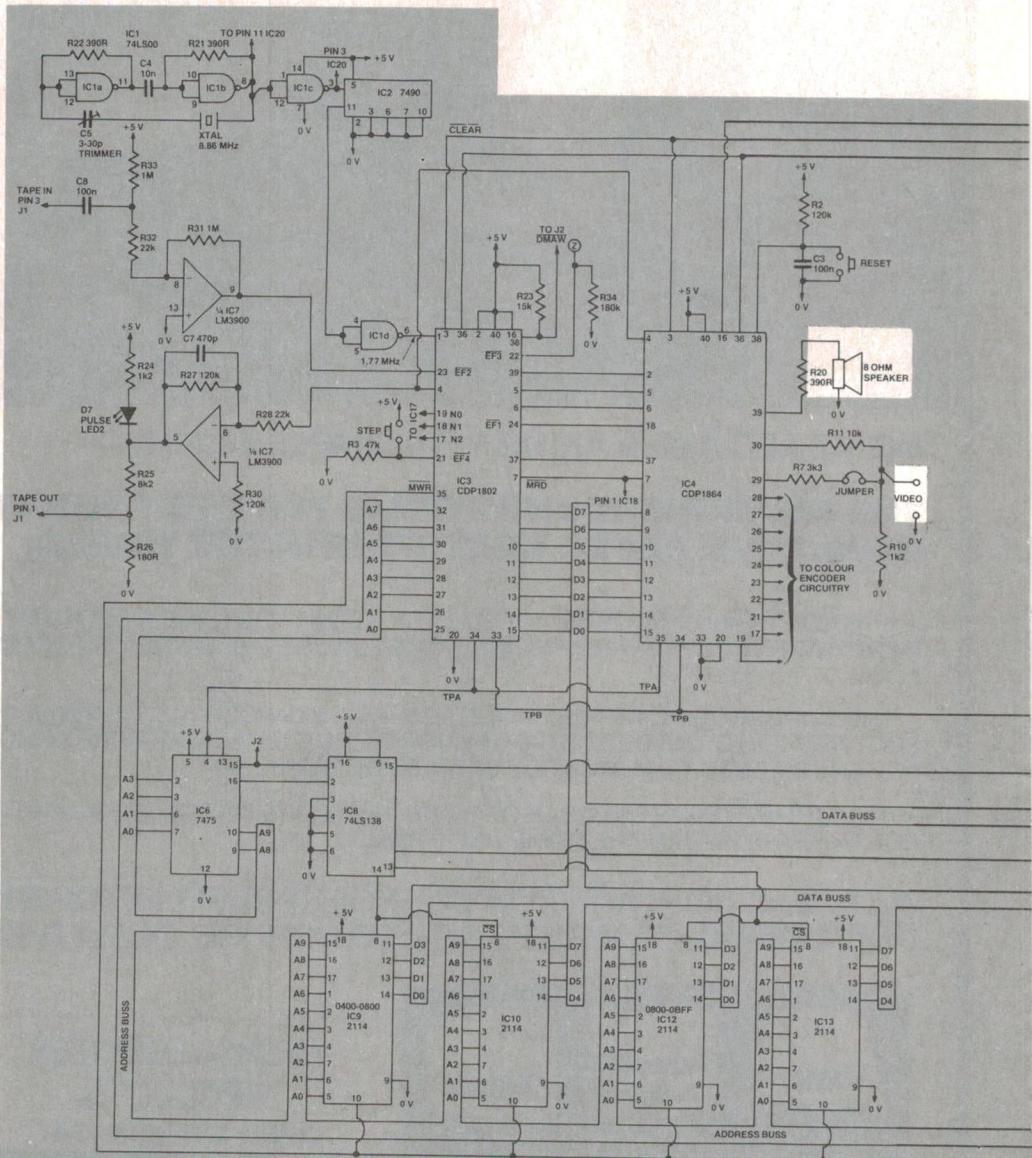
An 8 Vac/1 A output plugpack is used to power the project. Its output is rectified by a diode bridge, D1-D4, C1 being the filter capacitor. The dc output is regulated to 5 V by a three-terminal regulator,

IC24. Capacitor C2 is located physically as close as possible to IC24 and provides high frequency stability. For this reason it is a tantalum type. Capacitors C6, 9, 10 and 11 are supply rail bypasses located at strategic points on the tracks around the circuit board.

A 'power on' indicator is provided by D8 (LED1), a red LED which derives its bias current from the +5 V rail via R1.

### CLOCK

The clock consists of a crystal oscillator, employing IC1, and a divider providing a division ratio of 5:1. Two gates from IC1, a 74LS00 quad NAND package, are connected as inverters with inputs biased-up by a low value resistor from the output. One is coupled to the other via C4 and positive feedback around the two inverters is provided via the crystal and series trimmer capacitor, C5. The latter provides slight adjustment of the crystal frequency. A third gate from IC1 is connected as an inverter and drives the divider, IC2. Two outputs of opposite phase are derived from pin 8 and pin 3 of IC1 for the colour encoder circuitry.



# learners' micro

IC2 is a 7490 divide-by-10 counter arranged to reset on the fifth count. Its output, pin 11, is buffered and inverted by the fourth gate from IC1, IC1d, providing the required 1.773 MHz clock drive to the 1802 microprocessor.

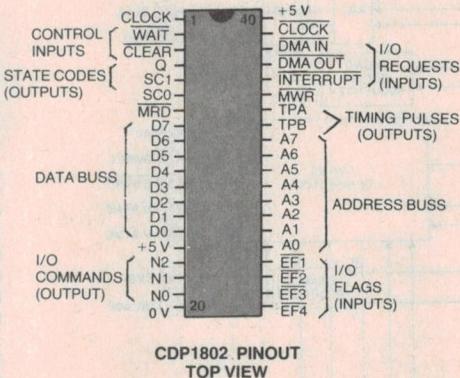
**CPU**

The 'architecture' and operation of the 1802 were detailed in Part 2 of this series (June '81, pp. 103-108). However, there are a number of specific things to consider in relation to gross features of its operation.

The STEP key applies a high (1) to one of the 'I/O Flag' inputs (pin 21) when pressed. This enables the processor to look at what the 6821 PIA is doing, via the data buss, and here it primarily permits instructions entered via the keyboard to be acted upon.

The 1802 generates two primary timing signals — TPA and TPB, available at pins 34 and 33, respectively. These are positive-going pulses that occur once each machine cycle (TPB follows TPA). They are used by I/O controllers (the 6821 PIA and 1864 Video Controller here) to interpret

codes and to time their interaction with the data buss. The trailing (negative-going) edge of TPA is used by the memory system to latch the higher-



order byte of the 16-bit memory address (see Part 2 of this series).

The 1802 controls the memory operation via pin 35 (MWR). A negative pulse appears on this pin during a memory-write cycle and it drives the 'Write Enable' ( $\overline{WE}$ ) pin of each of the 2114 RAM chips (pin 10). It works in conjunction with the 'Chip Select' ( $\overline{CS}$ ) signal derived by IC8 from IC6.

For video display purposes the 1802 provides a signal to the 1864 Video Controller which causes it to 'read' instructions from memory, via the data buss. This 'Memory Read' signal comes from pin 7 (MRD) and it goes low (0) to indicate a memory read cycle.

Input/output command signals come from pins 19, 18 and 17 — N0, N1 and N2 respectively. These are activated by an I/O instruction to signal the I/O control logic of a data transfer between memory and I/O interface. These are low at all times, except when an I/O instruction is being executed. During this time their state is the same as the corresponding bits in the N register. The direction of data flow is defined in the I/O instructions by N3 and is indicated by the level of the MRD signal (pin 7).

Here the N0-N3 signals go to a 4028 BCD-to-decimal decoder (IC17); it controls the 1864 Video Controller and the 6821 PIA.

The CLOCK input at pin 1 has a buffered output at pin 39, and this is used to drive the CLOCK input of the 1864 Video Controller.

## CASSETTE INTERFACE

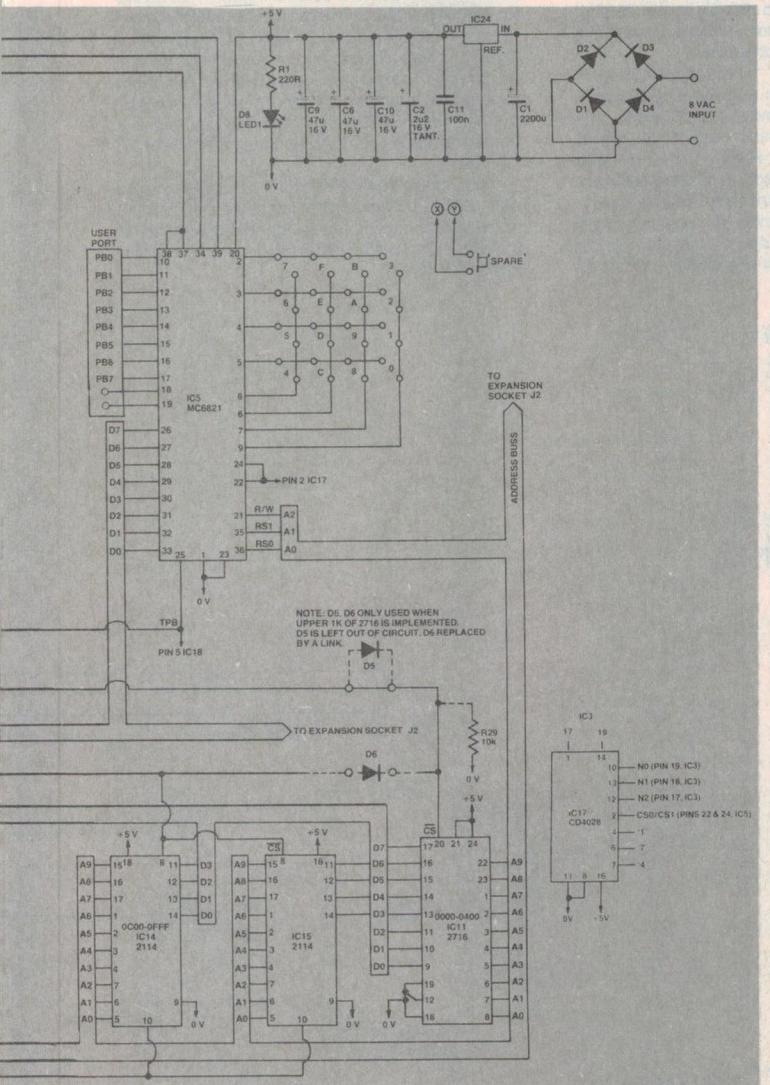
A useful feature of this project is the ability to store programs on audio (or 'data') cassettes using an inexpensive cassette recorder.

Programs are loaded onto tape in serial form (one bit after another) using two tones derived from the 'Q output' of IC3 (1802 CPU). This output is set and reset under program control.

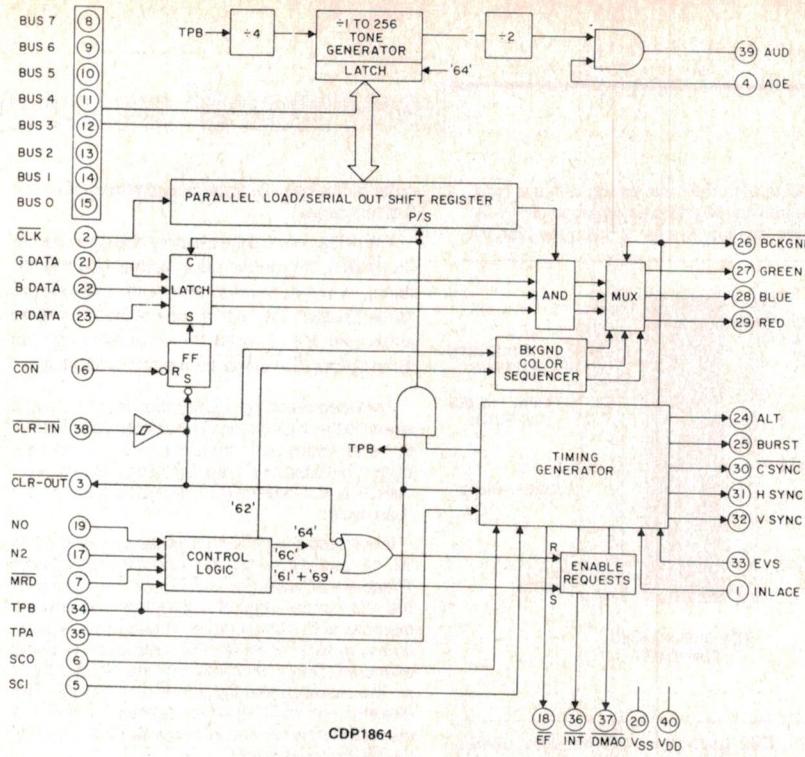
Pin 4 of the 1802 drives the input (pin 6) of one section of an LM3900 quad op-amp (IC7). This acts as an inverting buffer. Its output drives a resistive divider network with a LED (D7 — LED2) in series with it. As pin 5 of the LM3900 goes up and down the voltage at the cathode of D7 goes up and down, turning D7 off and on. This provides a visible indication of program execution and tape loading and for this reason D7 is labelled "PULSE". The output from pin 5 of IC7 is attenuated to a suitable level by R25 and R26, the junction of these two resistors going to the TAPE OUT pin of J1, the cassette interface socket. Cassette recorders requiring a different level for recording may be accommodated by changing the value of R25 down or up to increase or decrease the level, respectively.

To load a program from tape, the cassette recorder's output is fed into another section of the LM3900 quad op-amp. The TAPE IN signal is fed via C8 and R32 to the input of this op-amp, pin 8. This is arranged to have a gain of 50, and the output, from pin 9, will drive from 0 V to +5 V with the correct level of input signal from the cassette recorder. Pin 9 of IC7 drives pin 23 of the 1802 CPU. This is a 'Flag' input that is testable by software to be either true or false. The serial data is converted by software into 8-bit code and loaded into memory, starting at an address designated by the user. The CHIP-8 monitor accomplishes all this — a '2' command effects a load onto cassette, a '4' command enables you to read a program from the cassette.

The data rate of the serial data is derived from the master clock period, and ETI-660 owners should have little difficulty exchanging software on tape.



This portion of the circuitry shows the ETI-660 set up for monochrome operation and with all the RAM in circuit.



## VIDEO CONTROLLER

Internally, the CDP1864 Video Controller, IC4, consists of four major sections:

- (1) A timing generator that produces the necessary signals for video interface operations;
- (2) A parallel-in/serial-out shift register for screen dot generation;
- (3) A programmable audio tone generator;
- (4) Control logic for software control of the previous three sections.

The 1864 generates separate horizontal and vertical video synchronisation signals and a composite sync. For monochrome operation the composite sync. output (CSYNC — pin 30) is combined with the RED video output (pin 29) in a

simple resistor network to produce composite video. Note that this is a high impedance output and cannot be connected directly to the 75 ohm input of most video monitors. Colour operation is more complex and is described later.

The 1864 produces a 'bit-mapped' colour or monochrome display with a maximum resolution of 192 lines vertically and 64 dots (eight 8-bit bytes) horizontally. This resolution, which requires 1.5K of refresh RAM, is seldom used because of the poor aspect ratio of the resultant picture element ('pixel'). An approximately square picture element is obtained by repeating each horizontal line six times (done in software by the 1802) for a 32-row by 64-dot display. Whilst of

lower resolution, this display only requires 256 bytes of refresh RAM.

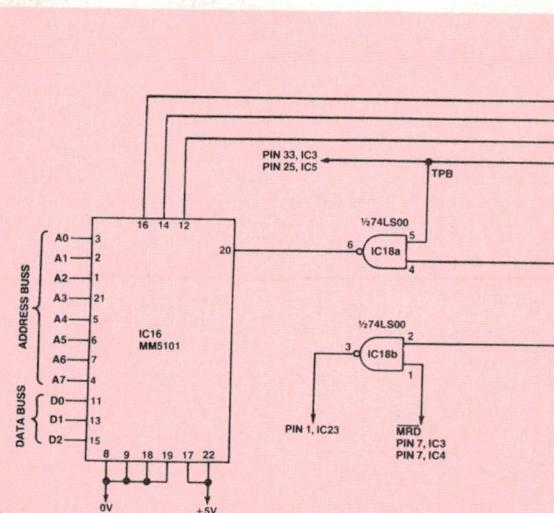
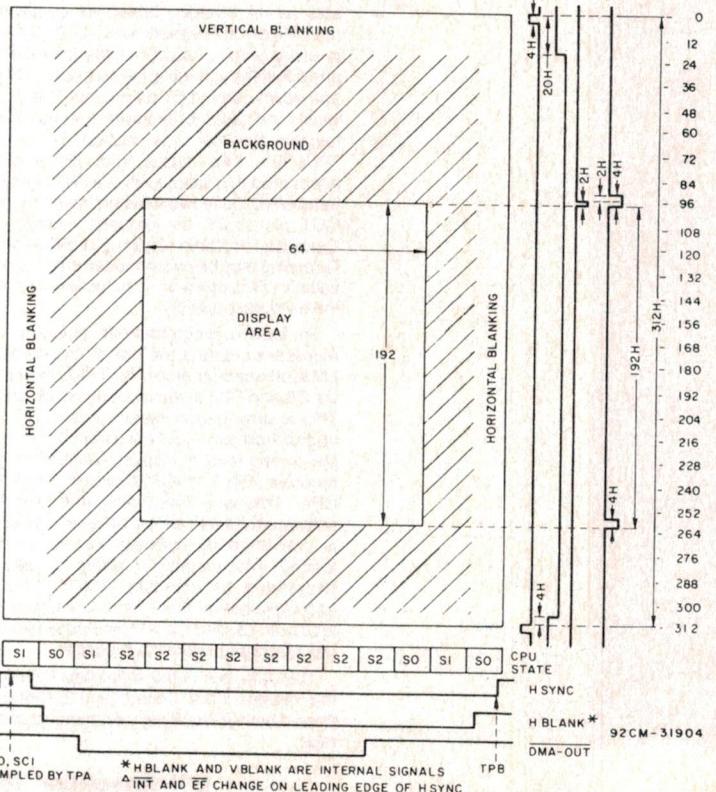
The programmable tone generator will produce 256 frequencies. Input is derived from the TPB signal from the 1802 (CLOCK  $\div 8 = 221.68$  kHz). This is internally divided by four (55.42 kHz) followed by an 8-bit programmable up-counter and a  $\div 2$  output stage. The programmable up-counter is reloaded automatically from the 8-bit tone generator latch each time it reaches the terminal count. The tone generator is loaded by the 1802 CPU from the data bus during a '64' output instruction.

A high (1) at the 'Audio Output Enable' (AOE) input (pin 4) of the 1864 allows the selected frequency to be generated at the 'Audio Output' (AUD) — pin 39. A low (0) on pin 4 holds the output (pin 39) low. A speaker is driven from the AUD pin, via R20. The AOE input (pin 4) is driven from pin 4 of the 1802 CPU, which provides the cassette interface output. This provides an audio indication during cassette loading. The level on pin 4 of the 1802 is controllable by a single-byte machine code instruction, to be set or reset under program control. Audio 'prompts' are thus provided to indicate key pushes on the keypad from the monitor program resident in IC11.

Another of the functions of the 1864 is to provide 'Clear' and 'Interrupt' signals to the CPU and I/O controller. The 'Clear' signal output is from pin 3, the 'Interrupt' signal output is from pin 36.

The RESET key is connected to the 'Clear Input' (pin 38) of the 1864. Pressing this key puts a low (0) on pin 38 and the internal logic virtually starts the Video Controller, and subsequently the 1802 CPU and 6821 PIA, from scratch. Internally, pin 38 is the input to a Schmitt trigger. This allows the use of a simple RC network (R2, C3) for power-on reset and debounce of the RESET key. When power is first turned on, C3 will be initially discharged, holding pin 38 low until it charges (about 10 ms or so) via R2. When the operator presses the RESET key, C3 discharges and any contact bounce is suppressed by the RC network R2-C3.

On applying reset, the colour, control, interrupt and DMA requests are disabled, making it necessary to include the colour enable software in the initiation routine (from the monitor program resident in IC11).



## COLOUR ENCODER

Additional circuitry is required to obtain colour video operation. This involves ICs 16 to 21, additional resistors and the colour delay line, DLY1. The 1864 Video Controller is employed to its fullest extent when colour operation is effected.

The video encoding circuitry is much more complex, as the composite video must contain composite sync, luminance and chrominance information. The luminance signal is obtained by combining the three colour outputs (RED, GREEN, BLUE) plus the background output (BKG) from the 1864 in a resistor matrix — involving resistors R4, R5, R6, R7, R8 and R10. The composite sync signal (CSYNC) is added in via R11. The value of each of these resistors is chosen so that the correct portions of each hue (colour) are added together to produce its correct luminance level. The background output is included in the matrix so that the luminance of background colour can be controlled, especially if the same colour is used for data in the display area.

It is more difficult to produce the chrominance signal, as it has to be phased correctly with reference to the burst pulses generated by the main crystal oscillator. To produce a PAL-compatible colour difference signal, outputs of IC20 are switched to the composite video output by a quad bilateral switch, IC21 (a 4066) via a resistor network R12-R19. The outputs of the two flip-flops in IC20 are switched through in sequence, driven by two opposite-phase signals from the 8.86 MHz clock, gated with the ALTERNATE output from the 1864 Video Controller. Each switch in the 4066 is driven by a video signal output from the 1864 (BURST, BLUE, GREEN, RED). This ensures the weighting resistors are switched through with the appropriate synchronism. The clock frequency (8.86 MHz) is twice the colour burst frequency of 4.43 MHz because of the divide-by-two action of the flip-flops in IC20.

The 400 ns delay line (DLY1) is included in the luminance line to compensate for the propagation delay of the colour signal in the encoder circuitry, achieving best results with colour operation.

Colour bit information is obtained from an additional RAM, IC16. This is selected as an I/O device by the I/O line decoder, IC17. Data is loaded into it from three lines of the data buss on

application of the TPB pulse from the 1802 CPU. This is gated with an output from IC17 to effect the Chip Select signal in a NAND gate, IC18a, one section of a 74LS00 quad-NAND gate. IC17 is a one-of-10 decoder that is used to decode the N bits (N0, N1, N2 — the I/O command bits) from the 1802 CPU to produce individual 'valid' lines for output or input codes (in hex, commands 61 to 67 and 69 to 6F). IC16 is a 256 x 4 bit RAM chosen because it has separate data input and output lines, making it easier to connect between the data buss and the 1864.

The 'video refresh' is accomplished via the DMA bit of the 1802 CPU, and synchronisation is provided by the INT, EF and State Code lines SC0, SC1. The latter are used to synchronise the 1864 to the 1802, providing a jitter-free display.

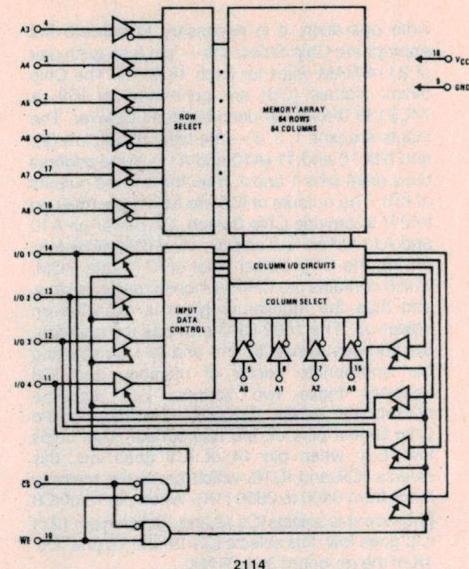
## RAM

The random access memory (RAM) uses 2114 ICs which are 1024 x 4 bit static RAM chips. This type of RAM is easy to use because being a 'static' type it requires no clocks or 'refreshing' as does 'dynamic' RAM. Power consumption, however, is higher, but can be offset by using slightly more expensive CMOS RAM chips, which we have done. The 2114 RAM is TTL signal and power supply compatible; data output has the same polarity as input data and shares the same I/O lines.

Internally, the memory array is arranged in a 64 x 64 block. Decoding is done by 'row' and 'column' select signals to produce a 1024 x 4 bit arrangement. With only a 4-bit data input it is necessary to use two 2114 chips per 1K (1024) block of memory as this machine uses an 8-bit data and address buss.

To enable access to each individual 'word' of the 1K block, it is necessary to use address lines A0 to A9. When the particular RAM is not required, it is isolated from the data buss by taking the 'Chip Select' line (CS — pin 8) high. This forces the I/O lines into a high impedance state.

'Reading' and 'writing' of data to and from memory is controlled by the 1802 CPU. When the MWD line (pin 35 of IC3, connected to pin 10 of each 2114) is low (0) and the Chip Select inputs of the appropriate 2114 pairs are low (pin 8), then data can be written into the RAM. When the Chip Select inputs are low and the MWD line high, data



2114

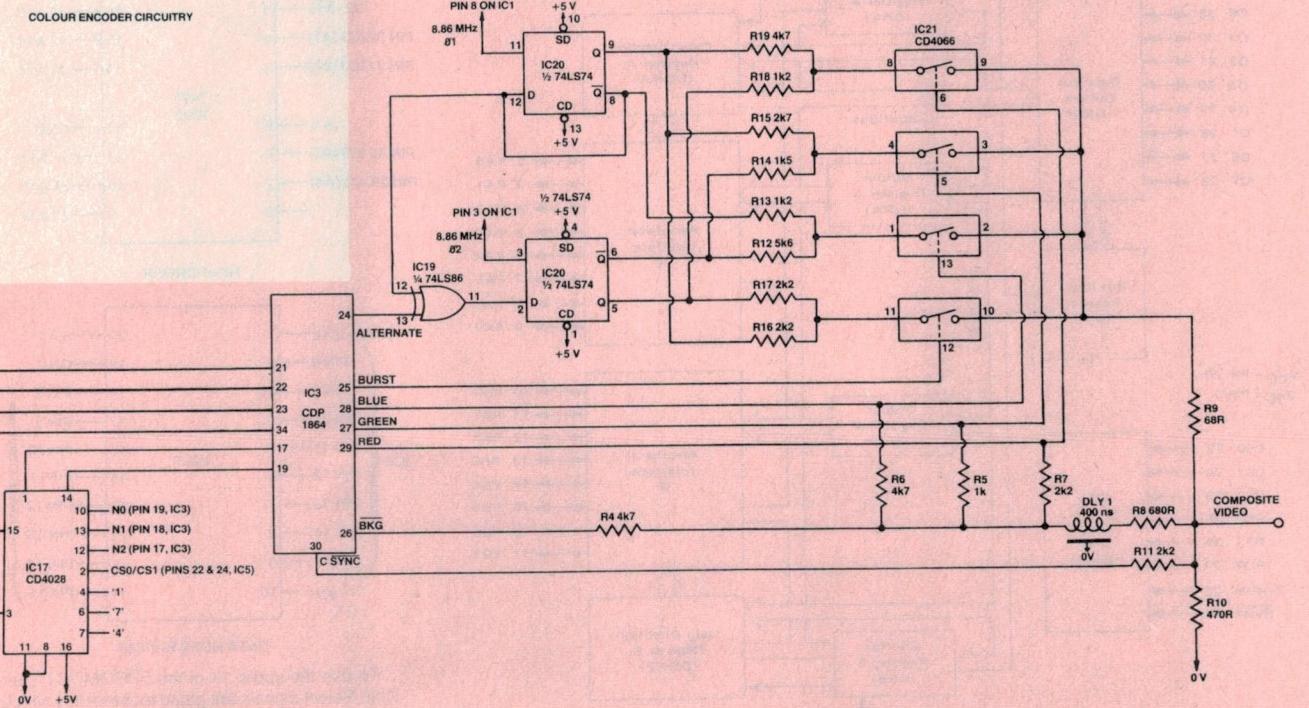
may be read from RAM.

The RAM chips are arranged in pairs, giving 1K blocks; IC9 and IC10 are for the 0400 to 0800 block of memory, IC12 and IC13 for the 0800 to 0BFF block, IC14 and IC15 for the 0C00 to 0FFF block. The CHIP-8 monitor program in IC11 occupies the 0000 to 0400 block of memory, but it is Read Only Memory (ROM) and we'll come to that shortly. For the minimum amount of RAM only IC9 and IC10 are required.

In Part 2 of this series the need for IC6, a 7475 4-bit address latch, was discussed. Its function is to demultiplex the higher order address lines A8 to A15. During the time the TPA output from the 1802 is low, the 7475 puts the data that was on address lines A0 to A3 when TPA went low onto address lines A8 to A11, while the 1802 CPU switches the lower order address byte onto the address buss lines A0 to A7. That's fine, but IC6 performs another function, in conjunction with IC8.

To select the correct RAM chips for the designated memory address during a memory read or ▶

COLOUR ENCODER CIRCUITY



write operation, it is necessary to activate the appropriate Chip Select line — pin 8 on each pair of 2114 RAM chips for each 1K block. The Chip Select signals (CS) are generated by IC8, a 74LS138 3-to-8 line decoder/demultiplexer. The inputs are pins 1, 2, 3 — the latter is held low (0), and bits 10 and 11 (A10 and A11) of the address buss drive pins 1 and 2, from the latched outputs of IC6. The outputs of IC8 are active low (they go to 0 V to provide Chip Select). On power-up A10 and A11 will be low and pin 15 of IC8 will be low, driving the Chip Select input of IC11 (the ROM, which contains the CHIP-8 monitor program) low, and thus the monitor program is available on power-up. The 1802 CPU provides the appropriate address signals to A10 and A11 for selecting the appropriate sector of memory, and IC8 decodes these two address bits and the appropriate output pin goes low, driving the Chip Select pins on the appropriate RAM chips low. E.g. when pin 14 of IC8 goes low, this selects IC9 and IC10, which serve the memory block from 0400 to 0800 (1K). When pin 13 of IC8 goes low this selects ICs 12 and 13; when pin 12 of IC8 goes low, this selects ICs 14 and 15 (the 'top' 1K of the on-board 3K of RAM).

It should be noted that data is read out of RAM non-destructively — you can read memory locations as often as you like and the data residing there will remain there until such time as you alter or remove it. The data read out has the same polarity as the data written into memory locations.

#### INPUT/OUTPUT

The MC6821 (IC5) Peripheral Interface Adaptor is a software-programmable I/O device that allows connection between the microprocessor and 'the outside world'. This IC comprises two completely separate 8-bit I/O ports — PA and PB — and four control lines, two per port, CA1-CA2 and CB1-CB2. On the 8-bit ports any bit (or line) can be software programmed to be an output or an input. CB1 (pin 18) and CA1 (pin 40) are only usable as inputs — mainly used to effect hardware interrupts. CB2 (pin 19) and CA2 (pin 39) can be

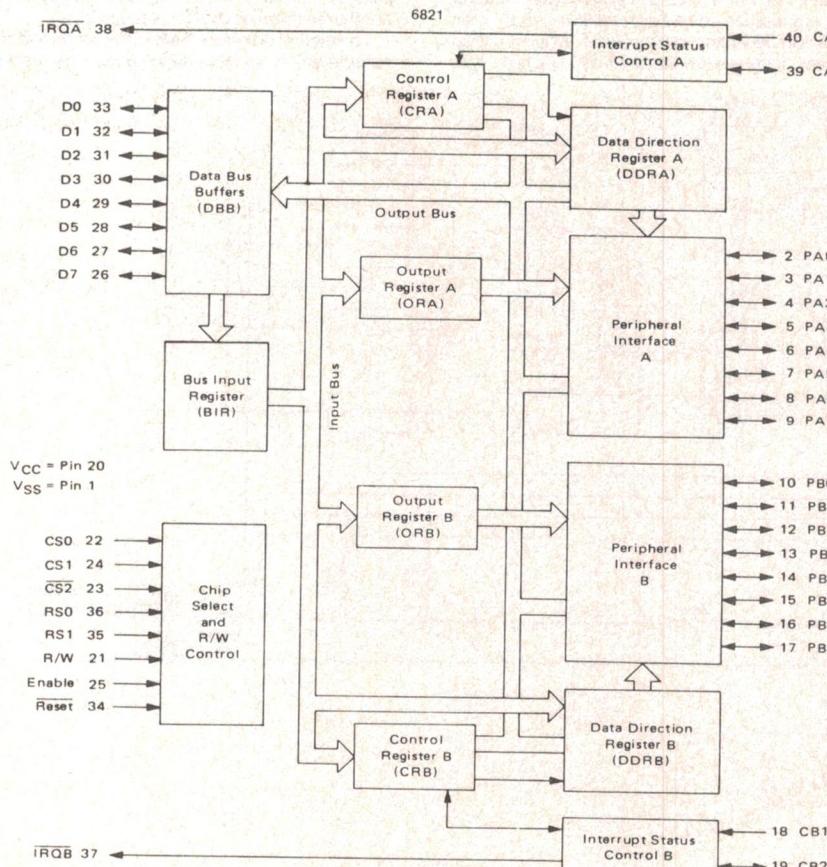
used as inputs or outputs, but not in the same way as the 8-bit lines. Port B involves pins 10 to 17 (bits 0 to 7), which are brought out to pads on the board for external connection, alongside pin 18 (CB1) and pin 19 (CB2).

Internally, each section — PA or PB — contains (i) a Control Register (CRA or CRB), (ii) a Data Direction Register (DDRA or DDRB). It is the function of the DDR to program the individual bits of the output register to be inputs or outputs. The Control Register is used to direct data on the data buss to DDR or the Output Register. After a hardware reset is done it is necessary to initialise the Output Register by using software in the monitor program resident in IC11.

The PA section of IC5 is used in conjunction with the keyboard. This is divided into a  $4 \times 4$  matrix with a normally open contact at each cross point. Pins 2 to 5 connect to the 'columns' of the matrix, while pins 6 to 9 connect to the 'rows' of the matrix. Internally, these eight lines have pull-up resistors, and when used as inputs are normally high when open. The 'row' lines (pins 6 to 9) are made output lines and are programmed in software to be logic 0. Pressing any key will join a row line (low) to a column line (high), pulling the column line (an input) low. The software (monitor program) detects this and changes the function of the rows and columns over to find the key depressed. Some short delay is normally included to 'debounce' the key contacts. Software is used to determine the 'value' of the key depressed.

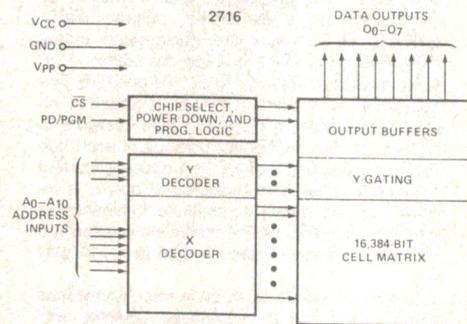
The PB section is user available but will require some additional machine code to program it.

The 6821 PIA and internal registers are selected by a combination of decoded 'N' lines from the 1802 (pins 17, 18, 19 — I/O command lines N2, N1, N0 respectively) and the lower-order address lines A0, A1, A2. The latter connect to pins 36, 35 and 21 respectively of the 6821 — these being inputs to the 'Chip Select & Read/Write Control' logic inside IC5. The CPU's N lines are decoded by IC17, a 4028 BCD-to-decimal decoder, one of its outputs driving two inputs to the control logic of the 6821.



#### ROM & CHIP-8

The CHIP-8 monitor program is contained in IC11, a 2716 or 2516 Programmable Read-Only Memory. This device is a 2Kbyte by 8-bit ultraviolet-erasable and electrically programmable ROM (EPROM). The 16 384-bit memory array inside the chip is decoded by 'X' and 'Y' decoders driven from the A0 to A9 address

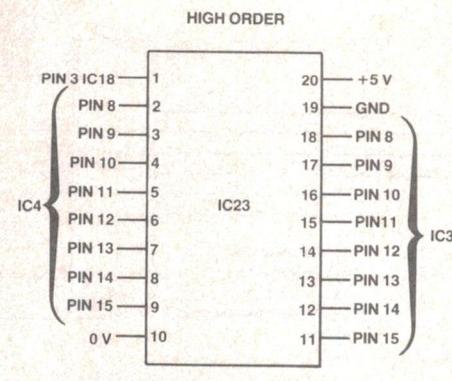
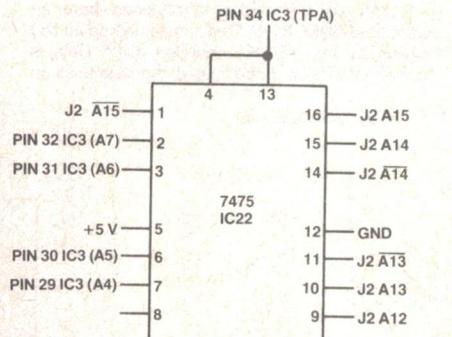


lines here, which gives 2048 8-bit 'words' of memory. Only half is used — the 'lower' order of memory. The 'higher' order (or upper half) may be programmed at a later date and provision has been made on-board to select the lower or upper half of ROM if necessary.

As explained before, a Chip Select signal is derived from IC8 and ROM is selected on power-up. As it is a read-only memory, no R/W control is required from the 1802 CPU.

#### EXTRAS

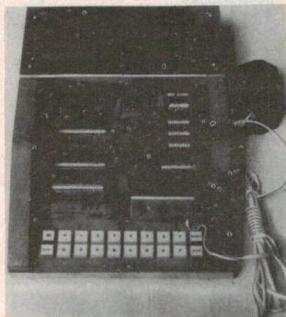
Provision has been made for later expansion of the project. For further RAM, the higher order address lines are decoded by adding IC22, another 7475, which functions in much the same way as does IC6. A data buss buffer, IC23, has to be added if external RAM is added. The expansion socket J2 provides connection to external RAM.



To use the upper 1K of the EPROM, IC11, two Chip Select signals are gated together in a simple diode gate — D5 and D6. Normally, D6 is replaced by a link on the board so that the ROM Chip Select signal is connected to IC11 and D5 is left out. R29 acts as a dc return when D5 and D6 are inserted.

(Article continues page 43.)

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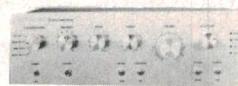
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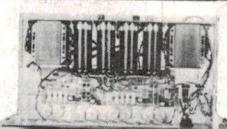
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# Project 660

— from page 33.

## Housing the 660

We chose to house the 660 in a simple, open case that may be readily constructed in the home or school workshop. It consists of a bottom piece on which the 660 pc board mounts, a top cover on which the speaker and 760 modulator mount and two wooden sides which complete the whole assembly. Mechanical drawings are available from us to enable you to make up the various parts of the housing. The top and bottom pieces are easily bent up with a simple bender or with two pieces of wood held in a vice. We used aluminium as it's easy to work with, but galvanised mild steel may be used if you wish.

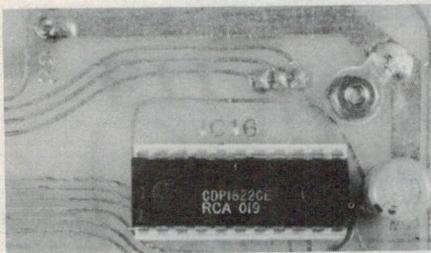
The top and bottom pieces should be cut to size and then drilled before bending up. The bottom has four holes to accommodate the stems of four 'mushroom-shaped' rubber feet. You can omit these holes and use 'stick on' rubber feet if you wish.

You will notice a large cutout on the rear foldup of the bottom piece. This is to permit access to the expansion part on the pc board (J2) later. The cassette interface DIN socket mounts on this rear foldup. We spray-painted the top and bottom plates white after they were drilled and bent up.

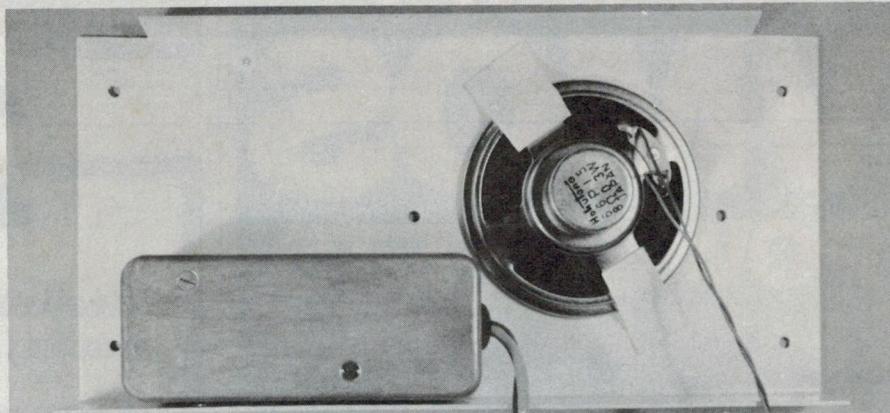
The components of the housing may be obtainable from some kit and component suppliers, either separately or with kits, if you don't wish or are unable to make them yourself.

Before assembling your 660 into its housing, first make the 8 Vac input lead to the board a permanent attachment. The figure-8 cable is looped through the two 4 mm diameter holes in the pc board adjacent to D1-D4 and the wires then soldered to the 8 Vac input pads.

Next take a twisted pair of hookup wires about 220-250 mm long and solder them to the SPK terminals on the pc board (near the end of C1). Now take three lengths of different coloured hookup wire about 200 mm long and solder them to the cassette interface connections on the pc board (J1). At this



The bottom plate of our housing was 'earthed' to the 0 V track on the pc board via a solder lug under a mounting bolt adjacent to IC16.



The 760 RF Modulator mounts to the top cover with its own cover retaining screws. We secured the 50 mm speaker with two sticky pads.

stage we will assume you already have your 760 modulator connected to the 660 pc board.

Now you can assemble the 660 pc board to the bottom piece of the housing. You will need five 12 mm long, 6 BA bolts and a total of 15 nuts. Pass a bolt through each mounting hole from the underside of the bottom plate and secure each with two nuts. These serve to space the pc board off the bottom plate. The bolt adjacent to the DIN socket hole has a 'star' washer secured beneath its head to provide an 'earth' connection to the 0 V track on the pc board. Now place the pc board over the mounting bolts. If all the holes are accurately drilled it should fit with little difficulty. If not, you will have to enlarge the appropriate hole or holes in the pc board a little until the board fits properly. Secure the board with four nuts — the exception being on that bolt adjacent to IC16. (The one with the star washer under its head). Fit a washer and a solder lug under the nut on this one and solder the lug to the 0 V track that runs around the end of the board here. (See accompanying photograph).

Now mount the cassette interface DIN socket to the foldup on the bottom piece and wire it up — making sure you have it correctly connected as per overlay drawing 3 or 5.

### MECHANICAL DRAWINGS, PCB, ETC.

Detailed mechanical drawings, pc board artwork and Scotchcal artwork (for the keyboard) can be obtained from us by sending a stamped, self-addressed envelope (at least 300 x 250 mm) to ETI-660 ARTWORK, ETI Magazine, 15 Boundary St, Rushcutters Bay NSW 2011.

The wooden side pieces may now be screwed to the bottom plate. Note that these are each secured by three screws on the underside and one screw on the rear foldup. We used small pan-head PK screws.

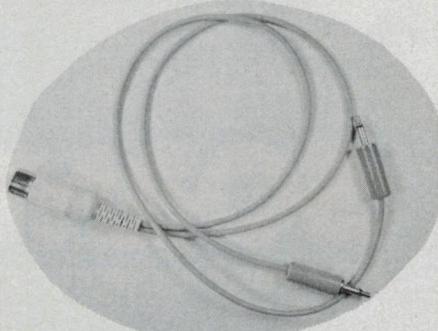
The 760 modulator may be attached to the top plate at this stage. Its orientation is fairly obvious — the RF output socket goes beneath the 15 mm

diameter hole. The screws that are supplied with the diecast box to secure its lid are here used to secure the box to the top plate of the 660 housing. Two access holes are provided in the top plate — one for the RF output connector of the modulator and one for tuning tool access to the 760's oscillator trimmer.

The speaker may now be secured to the top plate. There are several ways to do this. We used sticky pads to hold the speaker frame to the underside of the top plate. Alternatively, the speaker could be glued in position using a rubber compound such as 'Silastic'. You could also drill a couple of holes on opposite sides of the speaker position, just outside the diameter of its frame, and bolt the speaker in place using large washers to clamp the edge of its frame. We'll leave this up to you as precise details will depend somewhat on the physical dimensions of the speaker you're using.

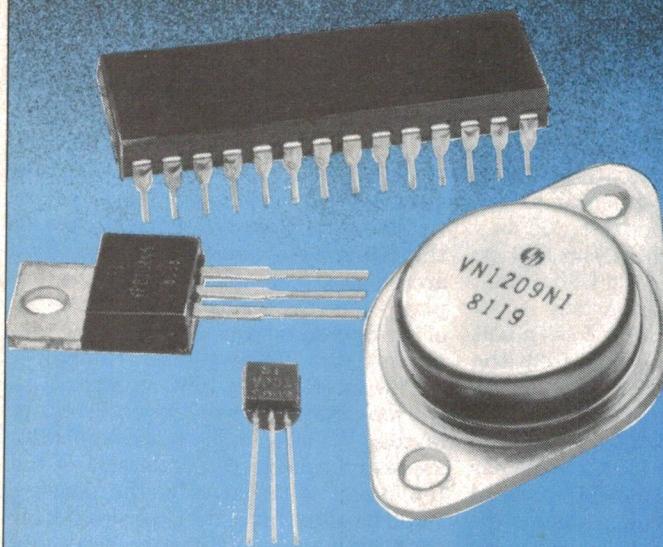
Once you have the speaker in position, wire it up. The top plate may then be screwed in position to complete the housing. Note that two screws secure the top plate to the wooden side rails and we used small PK screws, as before. Last of all, attach the four rubber feet to the bottom plate.

That completes the mechanical assembly, and you're ready to roll!



Make up a cassette interface cable. The DIN plug goes into the 660 and the two jacks to the recorder. To distinguish between the TAPE IN and TAPE OUT cables we made one longer and with a different coloured jack to the other.

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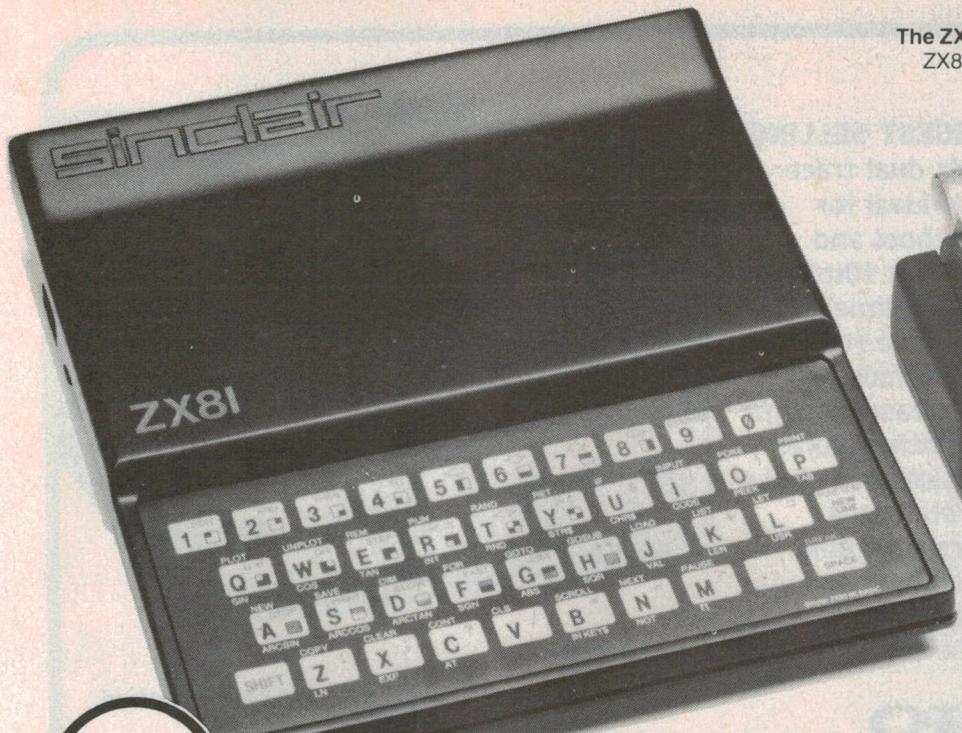
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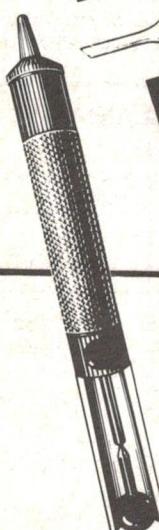
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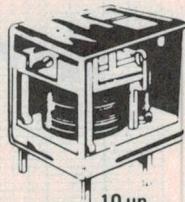
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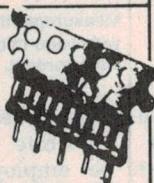
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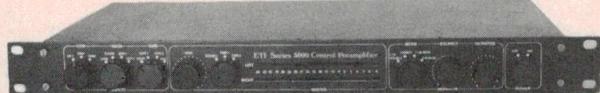
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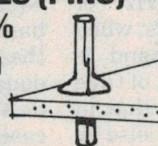
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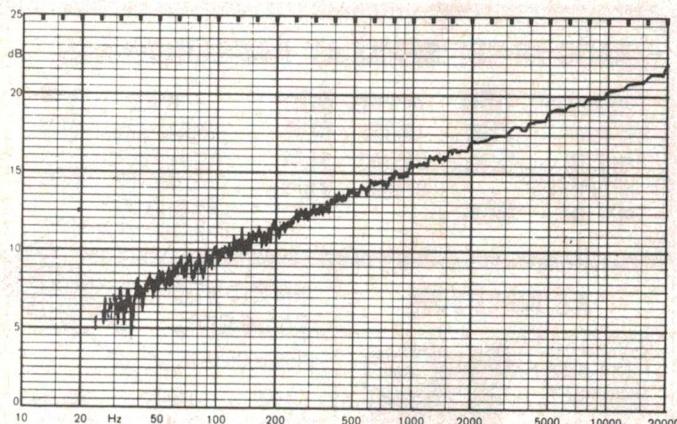
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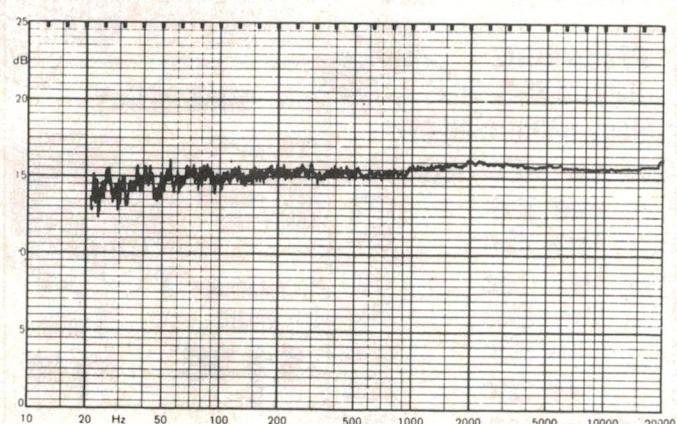
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## Audio 'white noise' generator employs digital technique

This project has many and varied applications, from a test signal source for audio systems through to a noise source for a 'sound effects' unit.



Measurement of the amplitude of white noise versus frequency as measured with a one-third octave filter set.



Measurement of the amplitude of pink noise versus frequency as measured with a one-third octave filter set. To the ear, pink noise appears to have more bass content.

WIDEBAND, or 'white', noise is a curious phenomenon, as it is a signal that contains a very wide spectrum of randomly distributed frequencies, all with random amplitudes, but it has equal amounts of energy in equal bandwidths over the total frequency range of interest. If you measured the noise energy in the band between 100 Hz and 200 Hz, for example, it would be the same as the energy between 3000 Hz and 3100 Hz, or 10 000 Hz and 10 100 Hz. That is, when the energy in a particular band is averaged over a reasonable unit of time it will have the same power as that in the same bandwidth anywhere else in the spectrum.

The basic sound of white noise resembles that of steam escaping from a valve. Electronic 'steam train' effects employ a white noise source to generate

the basic sound. Electronic music synthesisers include a white noise generator that can be employed to generate a variety of effects with suitable modification.

White noise and 'pink' noise are used for audio system testing in a variety of ways, which we don't have space to go into here. Pink noise is a modified version of white noise, where the signal is filtered to produce noise that has equal energy per percentage change in bandwidth. For example, the energy in the band 100 Hz to 200 Hz would be equal to that between 3 kHz and 6 kHz — a 100% change in bandwidth in each case.

To hear it, pink noise appears to have more bass content than white noise and also appears to the ear to have a more uniform output level in audio testing. To change white noise to pink noise, a

filter is required that rolls off with decreasing frequency at 3 dB per octave (10 dB per decade).

As this project has application in a variety of areas we have not provided details of housing the board as it may be built into some existing or planned equipment, used on its own, or used with filters and attenuators to suit your particular application.

### Making noise

There are several ways to generate white noise. Mother nature provides us with many sources in the electronic world, and an often-used source is the noise generated by a zener diode. We used this technique in the ETI-441 Audio Noise Generator (Jan. '76). However, it has the drawback that the output level is low and results vary widely from diode to diode.

# noise generator

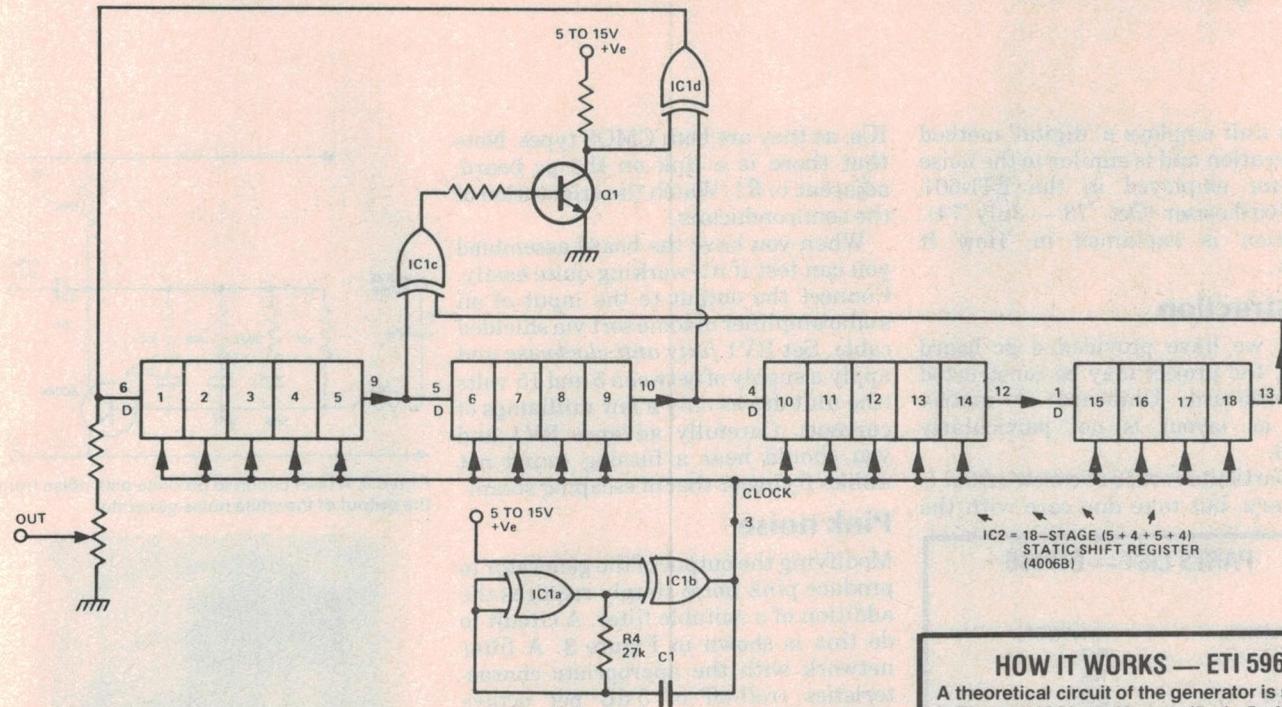


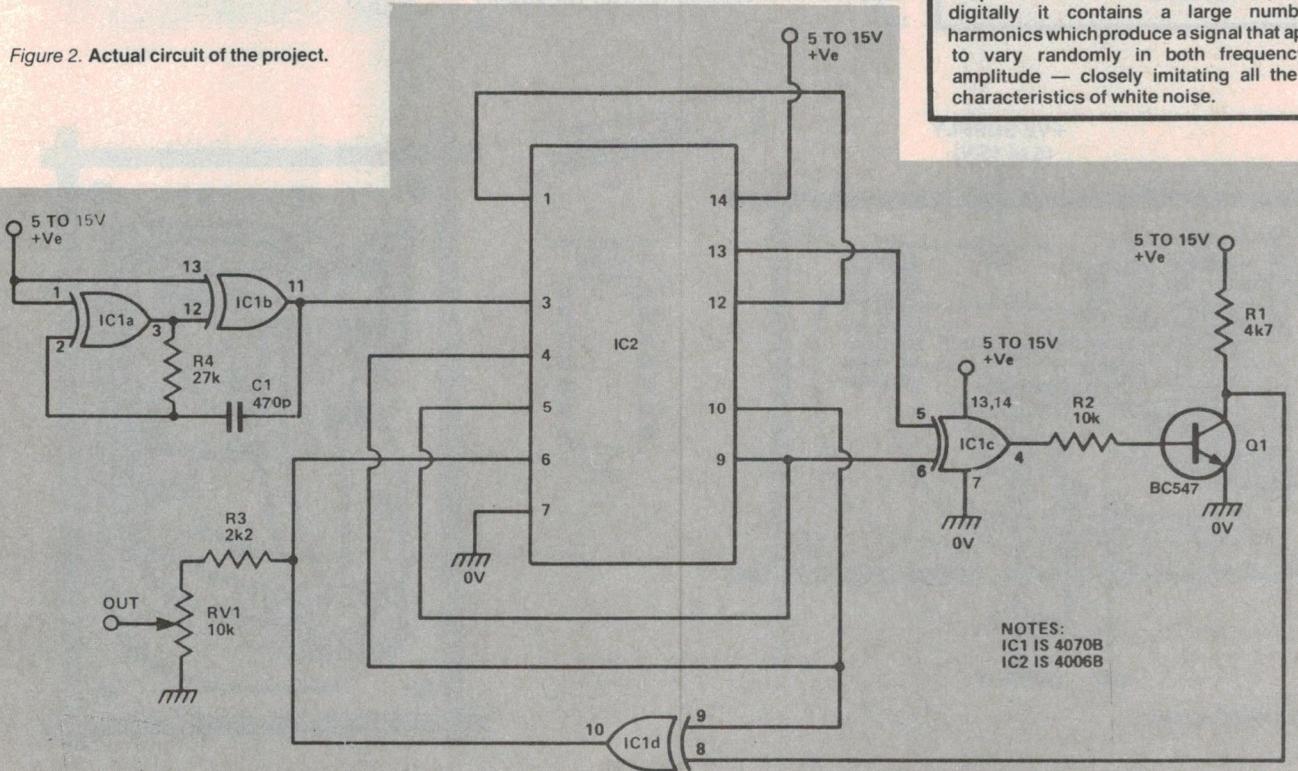
Figure 1. Theoretical circuit, illustrating the operation of the shift register.

## HOW IT WORKS — ETI 596

A theoretical circuit of the generator is shown in Figure 1. IC2 is an 18 stage (5+4+5+4) static shift register, in which the logic (0 or 1) information on the data (D) terminal is fed forward one step on the arrival of each pulse from a 60 kHz oscillator, IC1a-IC1b. Exclusive-OR gates IC1c-IC1d are used in conjunction with an inverter, Q1, to feed various outputs of IC2 back to the first data terminal in such a way that the data feeds through the register in an apparently random or jumbled fashion.

In reality, a complex sequence of 0s and 1s flows through the register, repeating once every few seconds and producing the apparently random jumble of fundamental frequencies. Since the waveform is produced digitally it contains a large number of harmonics which produce a signal that appears to vary randomly in both frequency and amplitude — closely imitating all the basic characteristics of white noise.

Figure 2. Actual circuit of the project.



# Project 596

This unit employs a 'digital' method of generation and is similar to the noise generator employed in the ETI-601 4600 Synthesiser (Oct. '73 — July '74). Operation is explained in 'How It Works'.

## **Construction**

Whilst we have provided a pc board design, the project may be constructed on Veroboard, Uniboard or matrix board as layout is not particularly critical.

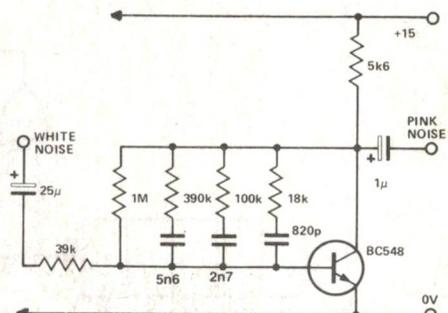
No particular order of construction is necessary, but take due care with the

ICs, as they are both CMOS types. Note that there is a link on the pc board, adjacent to R1. Watch the orientation of the semiconductors.

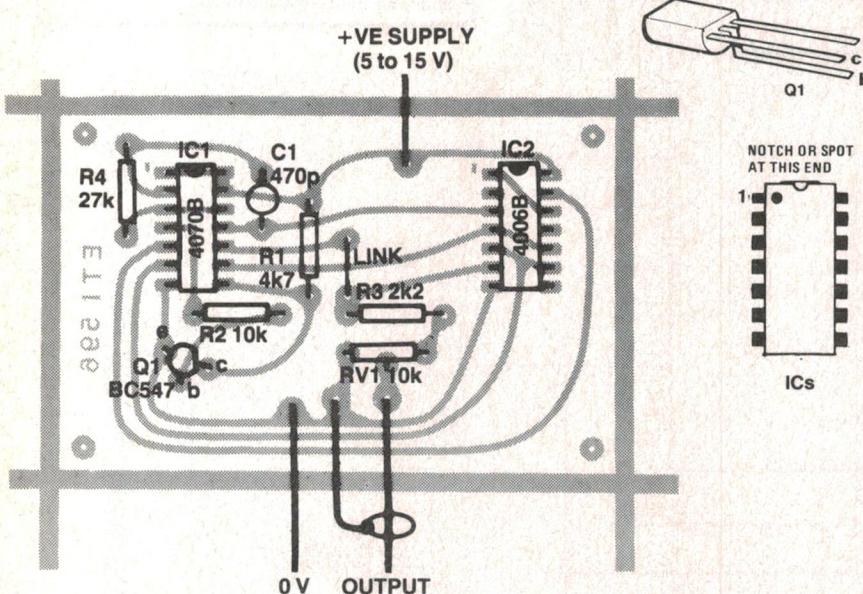
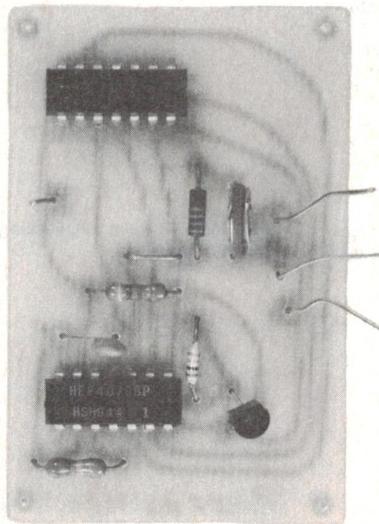
When you have the board assembled you can test if it's working quite easily. Connect the output to the input of an audio amplifier of some sort via shielded cable. Set RV1 *fully anti-clockwise* and apply a supply of between 5 and 15 volts (the unit draws only a few milliamps of current). Carefully advance RV1 and you should hear a hissing sound not unlike frying or that of escaping steam.

## Pink noise

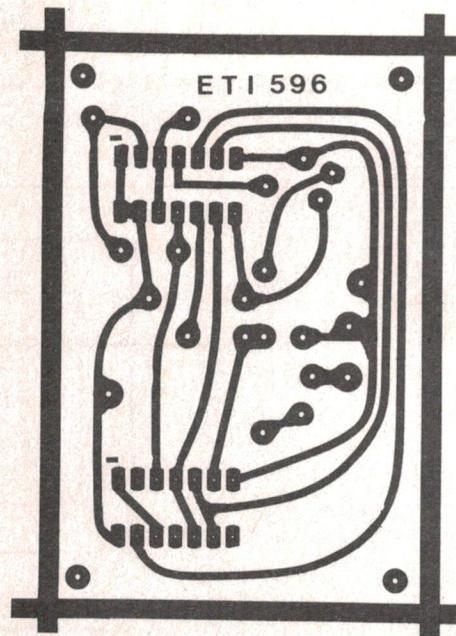
Modifying the output of the generator to produce pink noise simply requires the addition of a suitable filter. A circuit to do this is shown in Figure 3. A filter network with the appropriate characteristics (roll-off of 3 dB per octave above 20 kHz) is connected in the negative feedback circuit of a simple common emitter amplifier stage employing a BC548. Tantalum capacitors are recommended for the two polarised capacitors shown at the input (25 $\mu$ ) and the output (1 $\mu$ ). They should be rated at 16 V or more. The white noise input should be taken from the wiper of RV1 in the noise generator. Layout is not critical. A 220 $\mu$ /16 V electrolytic bypass capacitor is recommended for the supply rail.



**Figure 3.** A filter circuit to produce pink noise from the output of the white noise generator



### Component overlay.



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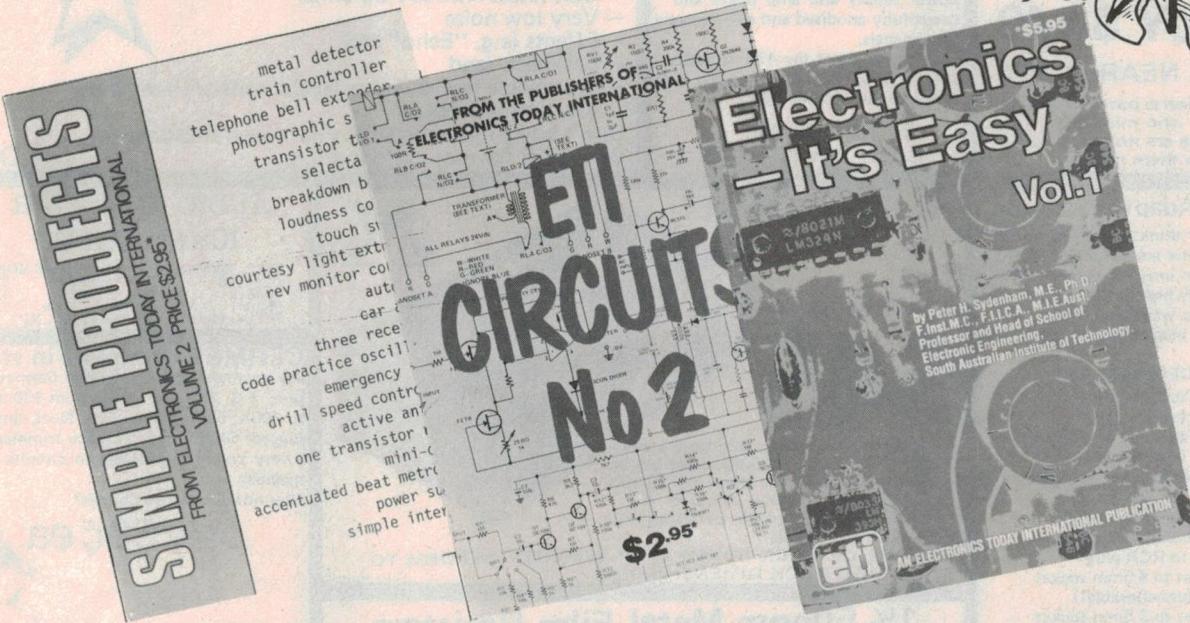
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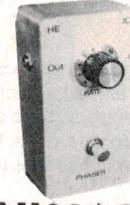
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## Test meter measures resistance from 100 ohms down to 0.005 ohms

At some time or another, every practical electronics hobbyist will need to measure a low-value resistance that the ordinary multimeter can't cope with. This project, which has applications in many situations, solves this problem.

**Design:** Ray Marston

**Development:** Simon Campbell

THERE COMES a time in the life of every person involved in electronics in a practical way when the need to measure a resistance outside the range of common multimeters arises. What do you do? Some squint at the scale of their analogue multimeter and guess that the needle, close as it is to the end of the scale, is somewhere in 'the ballpark'. Others stare at the LCD display of their digital multimeter and despair as it reads "00.2 ... woops, 00.3 ... um, 00.2" etc. At this stage you can resort to a power supply to drive some current through the resistance to be measured and use your multimeter to measure the voltage drop across it. If you can read 1 V on your multimeter with sensible accuracy you'll need to drive two amps through a half ohm resistance. And that's not a good idea for a transformer

winding rated at 200 mA, for example.

This project solves the difficulties generally experienced when you try to measure low value resistances. It has applications in many situations. When paralleling power transistors or three-terminal voltage regulators, for example, 'ballast' resistors are required so that each device in the circuit shares the load current equitably. These ballast resistors generally have values much less than one ohm, sometimes less than one-tenth of an ohm (0.1 ohm or 0R1). You can make a rough estimate of the length of copper wire of a particular gauge necessary to make a resistance of the desired value, simply from the published ohms/metre data on the wire gauge, but several pieces of wire cut to the same length from the same reel will not be the same resistance, and the

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Other applications are: measuring the resistance of transformer windings, measuring the resistance of cable joints, measuring the resistance of tracks on printed circuit boards, etc.

### Design

The instrument consists of a multi-range current source and a dc millivoltmeter. The measuring method is known as a 'four-terminal' technique and it has the advantage of eliminating the effect of the leads connecting the instrument to the resistance to be measured. The current source provides a predetermined constant current that is 'driven' through the resistance to be measured. The voltage drop across the unknown resistance is then measured with a high input impedance dc millivoltmeter. The meter reading is directly proportional to the resistance being measured. This gives a linear scale, which is an advantage. The maximum current supplied by the current source is about 100 mA (only on the 0R1 range), which is quite safe in the majority of circumstances encountered. ▶

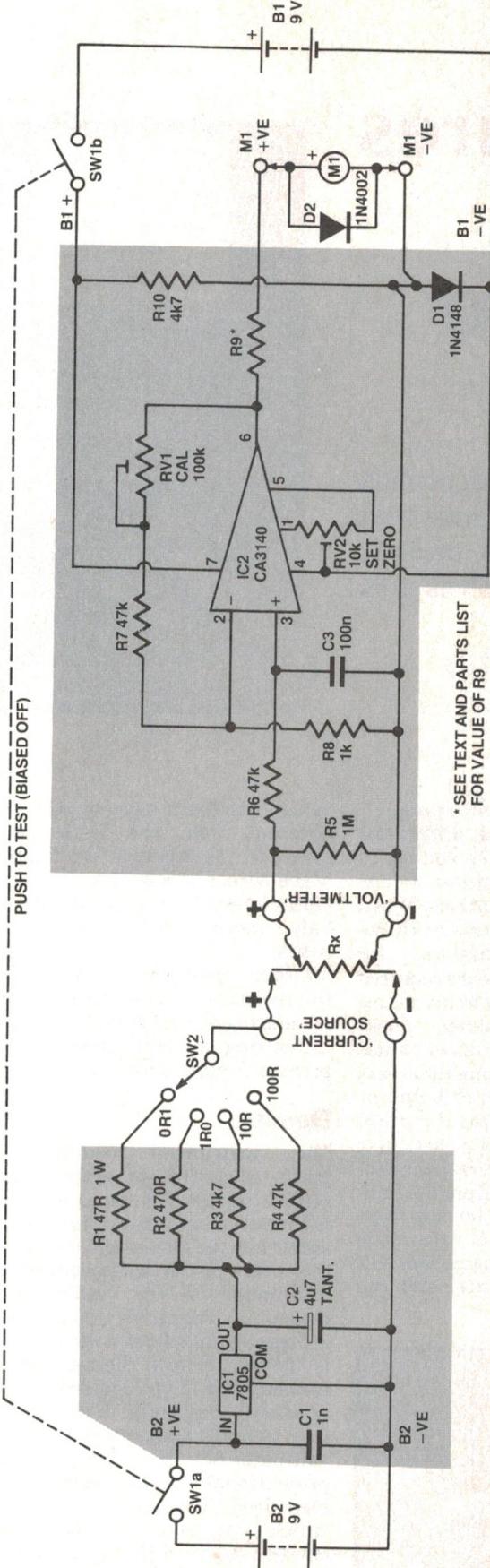
### SPECIFICATIONS — ETI 158

Ranges (full-scale):	100R, 10R, 1R0, 0R1
Resolution:	0.05 of full-scale reading (0.005 ohms on 0R1 range)
Accuracy:	2.5% of full-scale reading or better (depends on meter used)
Maximum test current:	100 mA (approx.) (0R1 range)
Minimum test current:	100 uA (approx.) (100R range)



Project 158

**PUSH TO TEST (BIASED OFF)**



The dc millivoltmeter has a full-scale sensitivity of 10 mV. The current source provides a current on each range such that 10 mV is developed across an unknown resistance of the maximum value in each range. This four-terminal technique is widely used in precision

measurement applications.

How does the instrument ignore the effect of the resistance of the connecting leads? Well, let us examine the worst case — say we are attempting to measure a resistance of around one-tenth ohm. The range switch (SW2) will be switched to 'OR1'. This selects R1 to limit the maximum current to be supplied from the voltage regulator I<sub>C1</sub>, which provides 5 V. Now, if each lead from current source terminals to R<sub>x</sub> has a resistance of half an ohm, a total resistance of one ohm will be connected in series with R<sub>x</sub>. If R<sub>x</sub> is one-tenth of an ohm (0.1 ohm or OR1), then the total resistance placed across the current source terminals will be 1.1 ohms. As this is in series with R1, the current now flowing through R1, the leads and R<sub>x</sub> will be given by:

of 1 V. Thus, whatever full-scale deflection value meter is used, 1 mA or 100 uA, R9 is selected so that the meter actually reads 1 V full-scale deflection. In fact, M1 and R9 may be dispensed with and you could use a multimeter set to the 1 V scale. Diode D2, mounted across the meter terminals, prevents damage to the meter if the units is incorrectly ranged so as to produce an output from IC2 of greater than 1 V. Being a silicon diode it will conduct when the voltage across the meter terminals rises to about 0.6 V.

So that any dc offset in IC2 can be compensated for, a zero set adjustment is provided. In order to set this accurately, the output of IC2 needs to be driven slightly negative and a small negative potential is developed across a forward-biased diode, D1. Current through R10 biases this diode on. To accurately set the full-scale reading of the dc millivoltmeter, the gain of IC2 is adjusted by RV1 with a known accurate resistance placed in circuit.

Capacitor C3 bypasses hum and noise at the input of IC2, picked up by the leads from the 'voltmeter' terminals connecting to  $R_x$ . As B2 has to supply up to 100 mA of current, a large-capacity battery is suggested. The dc millivoltmeter circuit only draws a few milliamperes and thus a standard 9 V transistor radio battery is all that is required.

HOW IT WORKS — ETI 158 —

much, much lower than the output of IC1. Consequently, the test current from the current source is virtually independent of both lead resistance and the unknown resistance. On the '0R1' range, one lead resistance of one ohm between the 'current source' terminals and the resistance being measured will only introduce an error of 2%. On the '100R' range, the same lead resistance will introduce an error of only 0.002%. The accuracy of the instrument is primarily determined by the tolerances of R1 to R4 and the meter accuracy.

The dc millivoltmeter is based on a CA3140 FET input op-amp. This IC has the advantage that it will respond accurately to dc inputs right down to 0 V. The voltmeter terminals are connected to the unknown resistance so that the meter circuit can indicate the voltage drop across the unknown resistance produced by the current source. The voltmeter circuit has a very high input impedance so that the current flowing into the voltmeter input resistance is very much less than the current flowing through  $R_x$ . The voltmeter input impedance is principally determined by  $R_5$ , a 1 M resistor. IC2 amplifies the voltage drop across  $R_x$ , its output driving a meter. The gain of IC2 is proportional to the ratio of  $RV1$  plus  $R7$  to  $R8$  and is set to about 100, so that a voltage drop of 10 mV across  $R_x$  will produce an output between pin 6 of IC2 and the 'M1 - VE' terminal.

The unit contains two separate circuits — a constant current source and a dc millivoltmeter. The constant current source drives a suitable current through the unknown resistance ( $R_x$ ). The current can be selected by means of a switch (SW2, the 'range' switch). The consequent voltage drop across the unknown resistance can then be measured with the dc millivoltmeter. As the resistance of  $R_x$  is directly proportional to the voltage drop across it, and the current driven through it is known to be a constant, the meter scale may

The constant current source is quite simple and comprises B2(9 V), IC1, R1 to R4, SW2 and associated components to the left of  $R_x$  in the circuit diagram. IC1 is a 7805 three-terminal 5 V positive regulator. Capacitors C1 and C2 provide high frequency stability. Resistors R1 to R4, selected by SW2, set the current that flows in the unknown resistance  $R_x$ . When the '0R1' range is selected, the current (limited by R1) will be around 100 mA. When the '1R0' range is selected, R2 will limit the current to around 10 mA ... and so on, through the ranges. Now, on each range, the value of the unknown resistance,  $R_x$ , will be very much lower than the value of the current limiting resistor (R1, R2 ... etc), by a ratio of around 500 to 1. The voltage drop across  $R_x$  will also be

$$\frac{5}{47 + 1 + 0.1} = \frac{5}{48.1} = 104 \text{ mA}$$

Now, if the lead resistance were zero, the current flowing through  $R_x$  will be given by:

$$\frac{5}{47 + 0.1} = 106 \text{ mA}$$

Thus a lead resistance of one ohm between the current source terminals and the resistance being measured will introduce a percentage error of:

$$(\frac{106}{104} \times 100) - 100 = 1.9\%$$

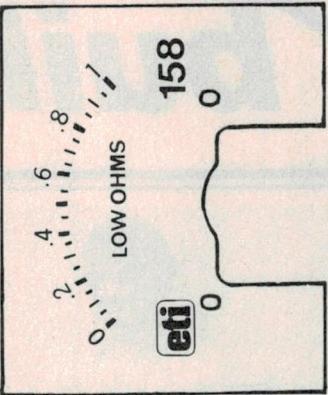
Looking at it another way, the ratio of the current-limiting resistor selected by the range switch ( $R_1, R_2 \dots$  etc) to the range switch ( $R_1, R_2 \dots$  etc) to the current source resistor ( $R_x$ ) will thus be

resistance of the connecting leads between the current source terminals and  $R_x$  is very high, and thus it is the current-limiting resistor which principally determines the current driven through  $R_x$ .

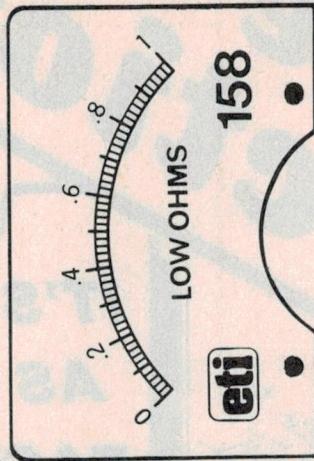
The dc millivoltmeter connects across the resistance being measured. It has an input impedance principally determined by  $R_5$ , as IC2 is a CA3140 FET input op-amp with an input impedance specified as 1.5 Terohms ( $10^{12}$  ohms). In the worst case, when using the 100R current source range and measuring a 100 ohm resistor, the dc millivoltmeter input impedance will be 10 000 times larger than  $R_x$  and its effect will thus be

insignificant. As the dc millivoltmeter is connected directly across the unknown resistance, and not across the current source terminals, the voltage drop across the leads from the current source terminals to the unknown resistance is ignored.

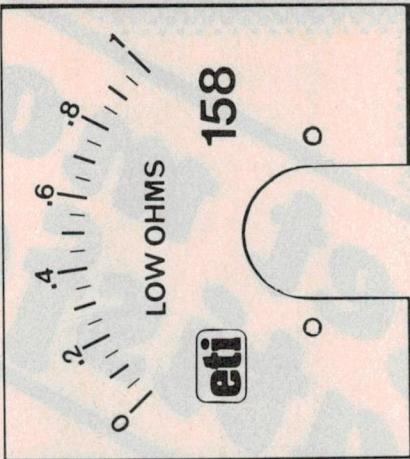
In practice, the accuracy of the instrument will be determined by the accuracy of the meter movement used. Most common, low-cost meter movements are 'Class 2.5' types with an accuracy of 2.5% of full-scale reading. A variety of meters may be used. The common 1 mA movements are inexpensive and there are several models around. Alternatively, 500  $\mu$ A or even



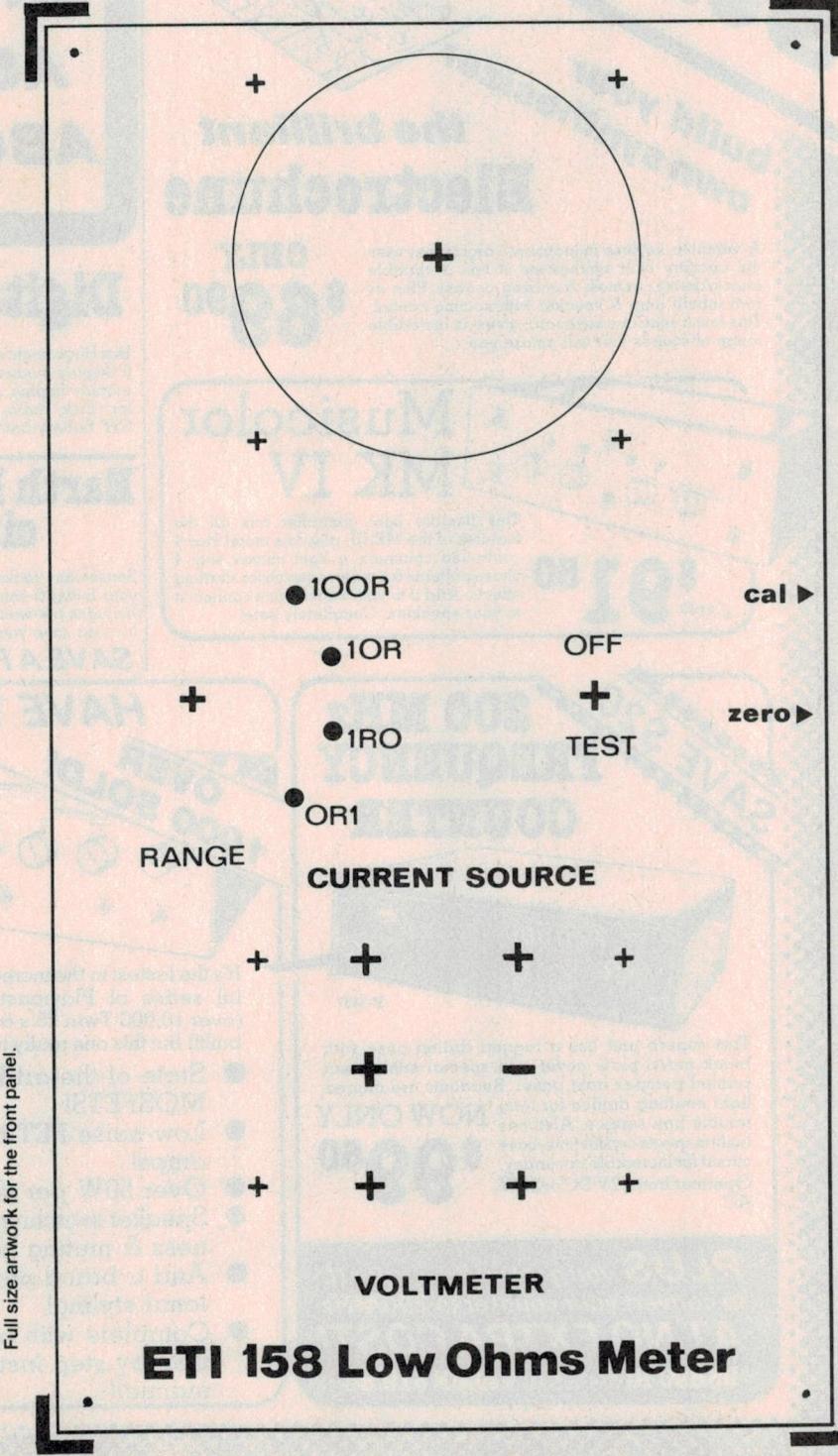
Scale for the Minipa MU-45.



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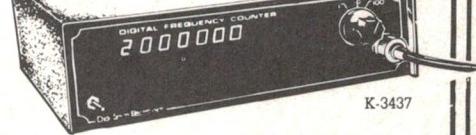
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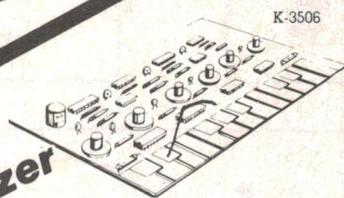


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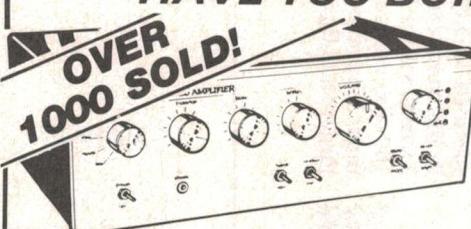
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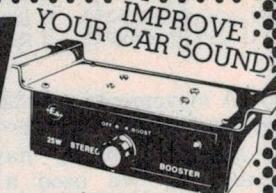
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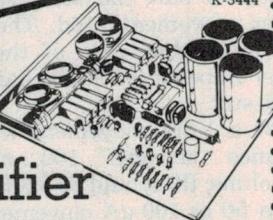
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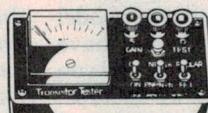
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K-3052

## CONTROL YOUR DRILL

This unit enables your drill to be slowed down to the point where it can be used to drill large holes in metal or even be used as a screwdriver. Suitable for most 240V universal brush-type motors. K-3080

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# Project 158

100 uA movements may be used. However, you'll find that different makes in the same sensitivity have different impedances. We used a University TD-66. These have a 100 ohm impedance in the 1 mA movement and a 2k impedance in the 100 uA movement. The Minipa meters in the MU-45 size have a 120 ohm impedance for the 1 mA movement, 1400 ohms for the 50 uA movement. The value of R9 needs to be chosen to suit the sensitivity of the meter movement used. The CAL adjustment takes care of the different meter impedances as the gain of IC2 is set to suit.

For a 1 mA movement with an impedance between 100 and about 300 ohms, R9 should be 820R 1% or 2%. For a 50 or 100 uA movement with an impedance of between 1k and about 3k, R9 should be 8k2 1% or 2%.

## Construction

The electronics are contained on a small 50 x 100 mm printed circuit board and the major components are mounted on the front panel of a conveniently sized jiffy box. While we have chosen to mount the electronics on a printed circuit board, layout is not critical and they may be mounted on matrix board, Veroboard, Uniboard or whatever.

If you elect to build your unit in the same fashion as we did our prototype, then the best place to start is with the mechanical work. We dressed up our front panel with a Scotchcal overlay, the design of which is reproduced on page 57. You can use this to mark out the drill hole positions on the jiffy box front panel. Note that the holes for the meter are marked out for a University model TD-66 meter movement. You will have to mark out holes to suit the meter you have if you intend using another type. Centre punch the holes to be drilled and then drill them carefully. Sizes will vary depending on the particular components used so we haven't given any hole dimensions. Note that for the voltmeter and current source terminals we used spring-loaded speaker terminals which are conveniently colour-coded black (-ve) and red (+ve). We drilled holes behind the terminals where the solder connection to each protrudes through the panel — no need to cut slots.

Cutting the meter hole can be a hassle if you don't have a hole cutter. There are several ways to do it. One is to mark a circle on the panel just larger than the diameter of the hole required. Then, using a 3 mm or 4 mm diameter drill bit, cut a series of holes around this ring

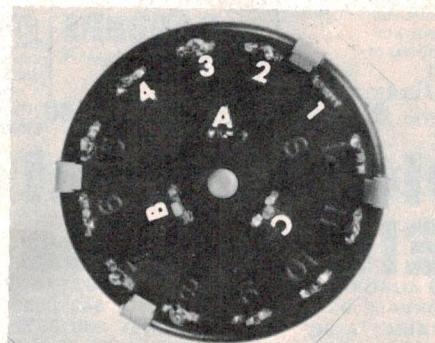
— each hole overlapping the last. The centre piece may then be pushed out and the edge of the hole cleaned up with a fine-cut half-moon file. Tedious, but it works. Another method again requires marking a hole just larger than that required and then drilling a large hole inside the circle, inserting a 'nibbling' tool and then cutting around the marked circle.

Having drilled the front panel, do a trial 'fit' of all the components that mount on it just to see that nothing needs to be adjusted or holes reamed out, etc.

If all is well, you can take the parts off the panel and then carefully stick the Scotchcal label to the panel and trim the edges. Next mount all the major components in place and orientate SW1 and SW2 so that their operation corresponds to the panel markings.

The pc board assembly may be tackled next. This is quite straightforward and the components may be assembled in any convenient order. Take care though with the orientation of IC1, IC2 and C2. Don't confuse R3 and R10. Note that R3 is a 1% or 2% metal film type whereas R10 is an ordinary 5% carbon type. Likewise, don't confuse R6 with either R4 or R7, as the former is an ordinary 5% carbon type and the latter two are metal film 1% or 2% types. Note that the two trimmers mount with their adjusting screws facing off the end of the pc board. Having completed the pc board, check it and then you can tackle the wiring from the board to the major components on the front panel.

Take care with the wiring to the voltmeter and current source terminals that you get the +ve and -ve connections the right way round. Note that diode D2 mounts on the meter terminals. Also make sure that you wire the meter the right way round. As a variety of switches are available to suit SW2 we have only shown a diagrammatic wiring arrangement for this, as the pins



Rear view of a C&K four-position switch showing the connections for SW2.

may differ between different switch types. The enclosed type, such as those from C&K, have the pole marked 'A' and the switch position marked '1,2,3,4' and they should be wired to conform to the designations on the wiring diagram. The connections to the open type of rotary switch are readily figured out by examination.

The only other item, or items, to watch concern the battery clip leads — make sure you connect them with the correct polarity.

Having got it all together, check your wiring and you're ready for a test flight. Plug in B1, and with nothing connected to the terminals, operate SW1 ('TEST'). Adjust the 'ZERO SET' trimpot to zero the meter.

Now, obtain a 100 ohm resistor — in fact, it is a good idea to buy a 100R 1% or 2% resistor for calibration use when you buy the rest of the components.

Plug in B2 and connect your resistor to the current source terminals. Take two leads with alligator clips on one end and connect the voltmeter terminals to the resistor — watch the polarity. Set the range switch to 100R and operate SW1. Now, adjust RV1 ('CAL') so that the meter reads full-scale deflection.

Now you're ready to roll, if all is well.

To permit adjustment of the CAL and ZERO trimmers with the project assembled in the case, we drilled two holes in the side of the case to permit access to the trimmer adjustors with a screwdriver. We located the hole positions by temporarily mounting the board in the case and marking the case on the outside where we judged the holes should be. Drill oversize holes and you can't go far wrong!

Assemble the pc board in the case, put the batteries in place and screw on the front panel. Repeat the zero procedure — but first adjust the meter movement mechanical zero, located at the bottom of the meter face. Then calibrate the unit on the 100R range using your 100R calibration resistor. Now you're calibrated and ready for work!

## Using it

The 'TEST' switch, SW1, is a spring-return type, so that the measurement current supplied by the current source is only applied for the length of time it takes to make the measurement. This helps to prolong battery life in case you leave the unit turned on and ensures that in applications where the 100 mA maximum test current may cause component heating that it is only applied for a limited period.

In use, always connect the current

# low ohms meter

source to the unknown resistance with heavy leads that are as short as practicable. The actual connections may well have the greatest resistance, so when using the 0R1 range make sure you arrange good, solid connections to ensure the best accuracy. The voltmeter should be connected with flying leads with clips on the end — always attach the clips across the actual resistance

being measured, not across the current source terminals or somewhere on the connecting leads.

To read off resistance, multiply the scale reading on the meter by the setting of the range switch. For example, if the meter reads 0.7 and the range switch is set to 1R0, the value of the resistance being measured is 0.7 ohms, or 0R7.

## PARTS LIST ETI-158

### Resistors

R1	47R/1 W, 1% or 2%
R2	470R/½W, 1% or 2%
R3	4K7/½W, 1% or 2%
R4, R7	47K/½W, 1% or 2%
R5	1M/½W, 5%
R6	47K/½W, 5%
R8	1K/½W, 1% or 2%
R9	820R, ½W, 1% or 2% (see text)
R10	4K7/½W, 5%
RV1	100k cermet multiturn horizontal trimpot
RV2	10k cermet multiturn horizontal trimpot

### Capacitors

C1	1n ceramic
C2	4u7/16 V tant.
C3	100n greenkap

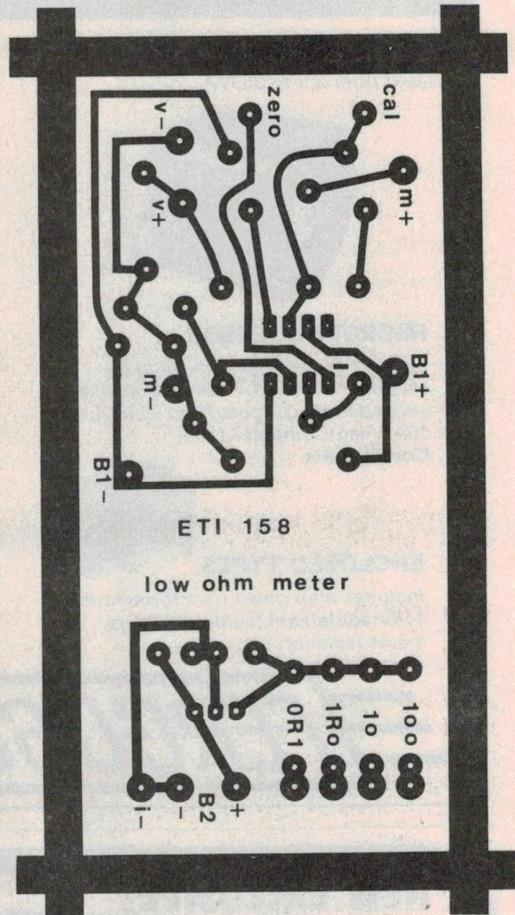
### Semiconductors

IC1	7805, LM340/T5 etc, 5 V reg.
IC2	CA3140
D1	1N914, 1N4148 etc.
D2	1N4001, EM401, 1N4002 or sim.

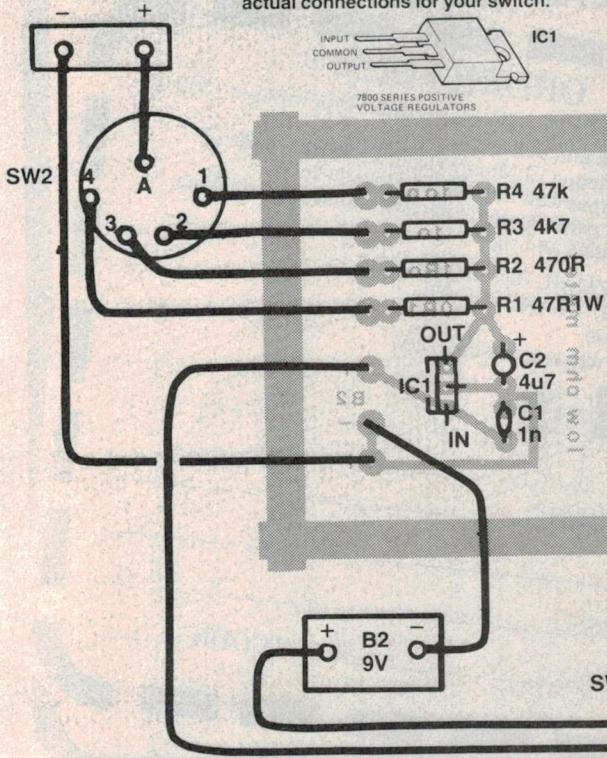
### Miscellaneous

SW1	DPST spring-return toggle switch
SW2	single-pole, four-position rotary switch
B1	No.216 9 V battery
B2	No.276P 9 V battery
M1	TD66 meter 0-1 mA, 100 ohms internal resistance (see text)

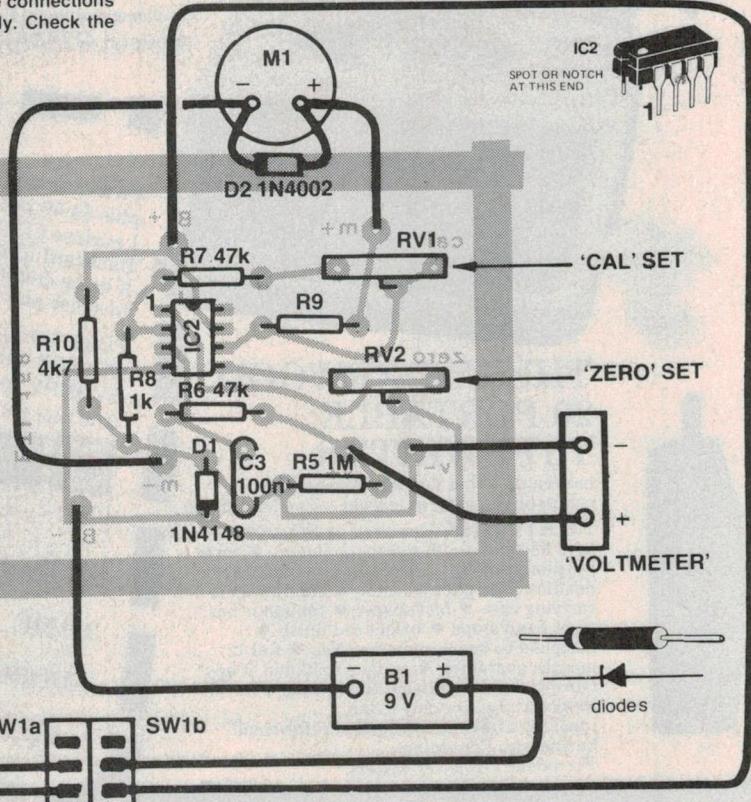
ETI-158 pc board; zippy box No. H0102  
196 x 113 x 60 mm or similar; Scotchcal front  
panel and meter scale; knobs; spring terminals;  
battery clips, etc.



### 'CURRENT SOURCE'



Overlay and wiring diagram. Note that the connections for SW2 are only shown diagrammatically. Check the actual connections for your switch.





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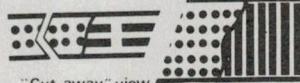
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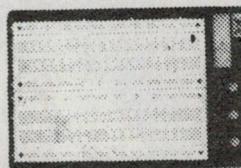
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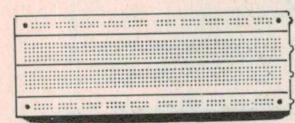
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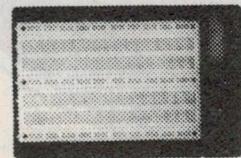
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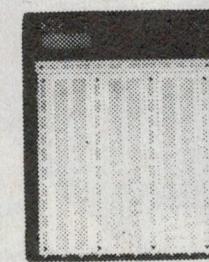
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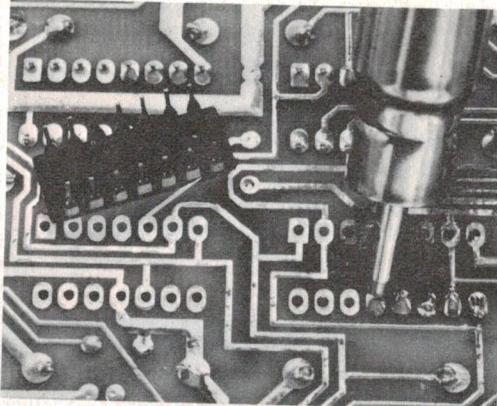
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# Lab Notes

## A look at the versatile 4046B

The 4046B CMOS chip is probably one of the most versatile and least-used of all the ICs in the CMOS range. The device glories in (or suffers from) the descriptive title of 'micropower phase-locked loop' and there is a widespread misconception amongst many electronics amateurs and professionals that the device can only be used in PLL-type applications. In fact nothing could be further from the truth.

THE 4046B CONTAINS a pair of phase-comparators, a zener diode and one VCO or voltage-controlled oscillator. All of these sections are independently accessible via the IC pin-outs. The VCO section of the device is probably the most versatile and cost-effective voltage-controlled oscillator on the market. It produces a well-shaped symmetrical square wave output, has a top-end frequency limit in excess of 1 MHz, can be voltage-scanned through a 1 000 000:1 range (1 Hz to 1 MHz) when used with a single timing resistor or through any range from 1:1 to infinity (0 Hz to 1 MHz) when used with a pair of timing resistors.

If that were not enough, the voltage-controlled oscillator can also be independently gated on and off via an INHIBIT terminal, can be operated from any supply in the range 3-18 V and can, when used in conjunction with one of the 4046B's phase comparators, produce a two-phase output. The linearity of the VCO is typically a healthy 1% or so.

### 4046B VCO circuits

Figure 1 shows the internal block diagram and the pinouts of the 4046B phase-locked loop IC. The device contains two types of phase comparator, a VCO and a zener diode. In practical PLL applications, the VCO and one or other of the comparators are interconnected to form a 'loop', which causes the VCO to lock to the mean frequency of an input signal connected to pin 14.

For our present purposes the most important element of the IC is the VCO,

Ray Marston

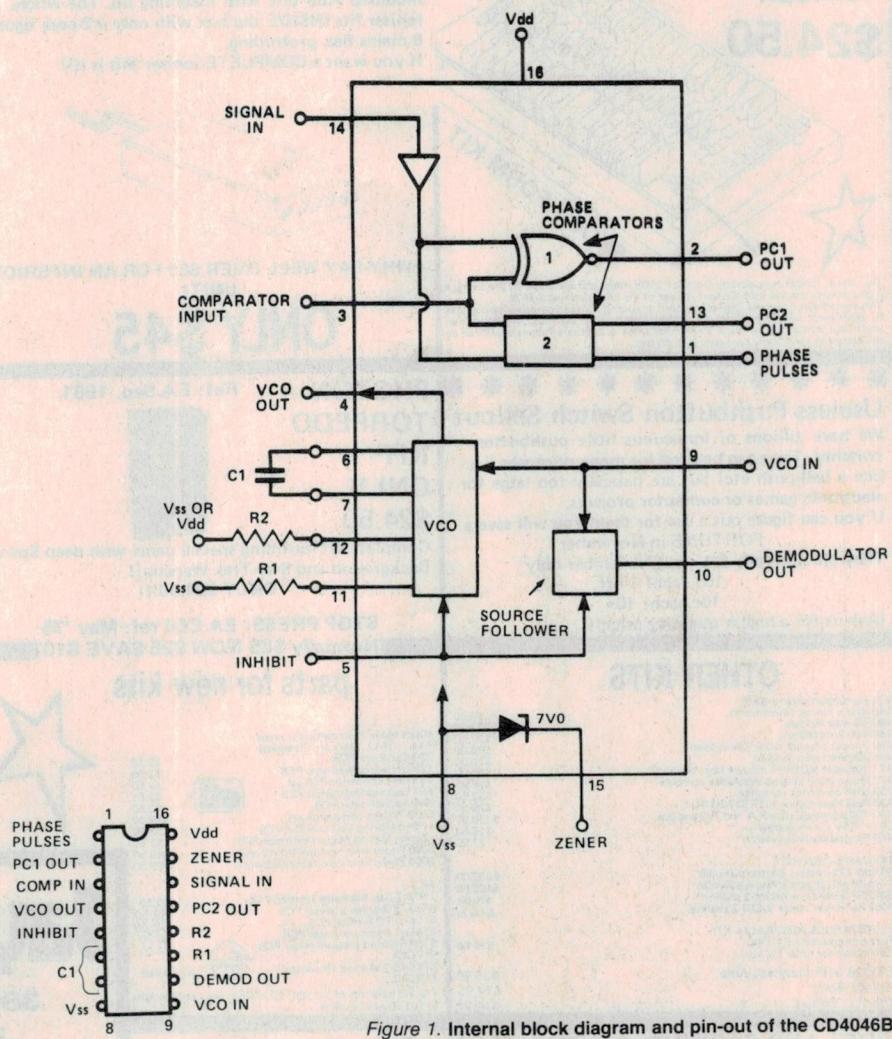


Figure 1. Internal block diagram and pin-out of the CD4046B micropower phase-locked loop CMOS IC.

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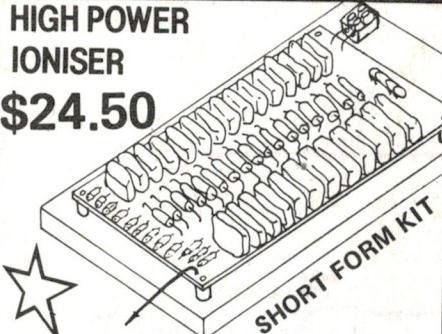


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(Ask us for a higher quantity price!!!)

## OTHER KITS

ETI (In no particular order)

- 446 Audio limiter (short form)
- 480/50 watt Module
- 480/50 watt Moduline
- 480 2 Input preamp/mixer (short form)
- 466 300 watt amp module
- 477 100 watt MOSFET module (inc. bracket)
- 473 Moving Coil preamp absolutely complete
- 735 UHF converter complete
- 458 Peak level meter NOT \$3.75 BUT  
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- 445 12V power supply
- 581 +/-15V Power Supply
- 445 General purpose preamp

JAYCAR'S OWN KITS

- 88 note (76 keys) electric piano kit
- 4-voice polyphonic string synthesiser
- 3002-SP Speaker protector 2 channel
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ELECTRONICS AUSTRALIA KIT

Fuzz box complete EA Feb

(See above for other EA kits).

ET1729 UHF Masthead Amp

EA 'Le Gong'

EA 'P.C. Birdies'

## CMOS Specials Back!!

We have bought the entire stock of the mail order company 'Micronics' of Randwick NSW. They wanted to get out of the business so their loss is your gain!

Most of the CMOS below are the 'AE' type (NOT B but they are prime spec. brand new stock.

PART NO.	NORMALLY	THIS MONTH
4000AE	0.40	0.25
4002AE	0.48	0.25
4006AE	1.10	0.50
4012AE	0.35	0.20
4014AE	2.50	1.00
4018AE	1.50	0.50
4023AE	0.28	0.15
4026AE	2.20	1.00
4028AE	1.18	0.50
4029AE	1.25	0.55
4035AE	1.30	0.50
4047AE	1.20	0.50
4050AE	0.60	0.30
4051AE	0.95	0.40
4055AE	2.55	1.00

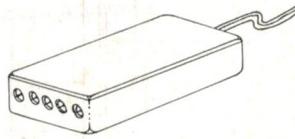
## COMPLETE IONISER KIT

BY POPULAR DEMAND

Based on the Jaycar High Power Ioniser short form kit (see left).

This unit has redesigned PCB, HIGH EFFICIENCY Emitter Head that fits inside a high quality moulded ABS box with matching lid. The whole ioniser fits INSIDE the box with only a 2-core figure-8 mains flex protruding.

If you want a COMPLETE ioniser this is it!!



- WHY PAY WELL OVER \$80 FOR AN INFERIOR UNIT?

ONLY \$45

## PHOTON TORPEDO KIT ONLY \$24.50

Complete kit including special panel with deep Space Background and Star-Trek Warship!!  
ONLY \$24.50!!!



STOP PRESS: EA CDI ref: May '75  
Normally \$35 NOW \$25 SAVE \$10

parts for new kits

\$9.00	\$23.00
\$27.00	\$30.00
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(Once again in no particular order)  
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458 Peak reading meters PCB  
448 Audio limiter PCB  
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478mm Moving Magnet cartridge PCB  
5000 Power amp heatsink front panel  
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EA	75K-7 Cap Discharge Ignition PCB	\$2.50
81GA-3 Graphic analyser PCB	\$9.50	
81CC-5 'PC Birds' PCB	\$2.50	
81AO-6 Audio oscillator PCB	\$3.70	
81BG-8 Sound pressure meter PCB	\$3.00	
81RC4-1 RC circuit PCB		
81RC4-2 Channel IR control		
81RC4-3		

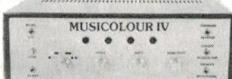
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ONLY  
\$94.50

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(Ref: EA August 1981)  
This is our third production run! Remember our kit uses the originally specified box (which means that the front panel fits!). Don't forget also that this is a chaser (4 channel) AS WELL AS a 4 channel Musicolor!!  
Great lightbank to suit above unit ONLY \$29.50 (Check last months ad for details).

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A great kit that is easy to install and has inbuilt false-trigger preventative mechanism. This kit has been held up due to non-availability of the LM394 I.C. This device is now becoming available.

Kit in Diecast box (complete).

ONLY \$24.50

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We know that it's crazy but we're doing it anyway. For the month of November ONLY we have gone crazy with panel lamps. If you buy ANY Jaycar panel lamp that uses an incandescent (i.e. Lilliput or MES) bulb we will give you

And that's 50% off the best price anyway!!!

50% OFF!!

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\$7.50 ME-533 MULTIMETER CURRENT SHUNT

Hand made. Plug into your meter.  
Measures up to 20 AMPS with direct meter readout.  
VERY ACCURATE

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SORRY - due to weight, personal shoppers only or \$2.00 post and packing.

ONLY \$3.00!! SAVE OVER 60%

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We now stock ELLISTRONICS plug-in Experimenters Boards!



NOTE! NEW  
SHOP HOURS  
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POST AND PACKING: \$5-\$9.99 (\$1.00): \$10 - \$24.99 (\$2.00): \$25 - \$49.99 (\$3.00): \$50 - \$99.99 (\$4.00): \$100 up \$5.50

# Lab Notes

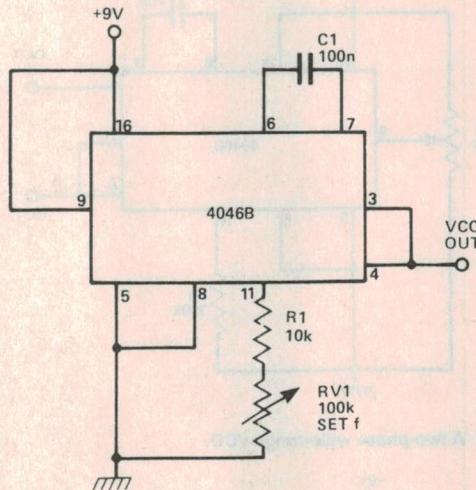


Figure 2. Simple variable-frequency (200 Hz to 2 kHz) square wave generator.

or voltage-controlled oscillator. The operating frequency of the oscillator is governed by the value of a capacitor connected between pins 6 and 7 (minimum value 50 pF), by the value of a resistor wired between pin 11 and ground (minimum value 10k) and by the voltage applied to VCO-input pin 9 (any value up to the supply voltage in use).

Figure 2 shows the simplest possible way of using the VCO section. Here, the pin 9 'voltage control' input is tied permanently high and the circuit acts as a basic square wave oscillator, with its frequency variable over a 10:1 range by RV1. Note at this point that the VCO output (pin 4) is tied directly to the pin 3 phase comparator input. If pin 3 is allowed to float, the comparators tend to

self-oscillate at about 20 MHz and superimpose an HF signal on the top part of the VCO output waveform.

## Ranging far and wide

Figure 3 shows how to connect the 4046B as a wide-range VCO. Here, R1-C1 determine the top (maximum) frequency that can be obtained and RV1 controls the actual frequency via the pin 9 voltage. The frequency falls to near zero (a few cycles per minute) with pin 9 at 0 V. The effective control range of pin 9 varies from roughly 1 V below the supply value to 1 V above zero, i.e.: RV1 has a 'dead' control area of several hundred millivolts at either end of its range.

Figure 4 shows how these 'dead' areas can be eliminated by wiring a silicon

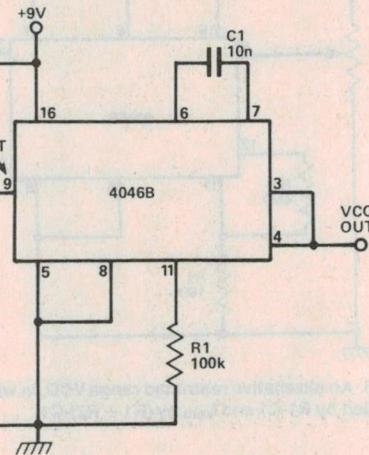


Figure 3. Wide range VCO with frequency variable from near zero to 1.4 kHz via the pin 9 voltage.

diode in series with each end of RV1. The circuit also shows how the minimum operating frequency can be reduced to absolute zero by wiring a high value resistor (R2) between pins 12 and 16. Note here that, when the frequency is reduced to zero, the VCO output randomly settles in either the logic 0 or logic 1 state.

Figure 5 shows how the pin 12 resistor can alternatively be used to determine the minimum operating frequency of a restricted-range VCO. Here,  $f_{\min}$  is determined by R2-C1 and  $f_{\max}$  is determined by C1 and the parallel resistance of R1-R2.

Figure 6 shows an alternative version of the restricted-range VCO, in which  $f_{\max}$  is controlled by R1-C1 and  $f_{\min}$  is determined by C1 and the series com-

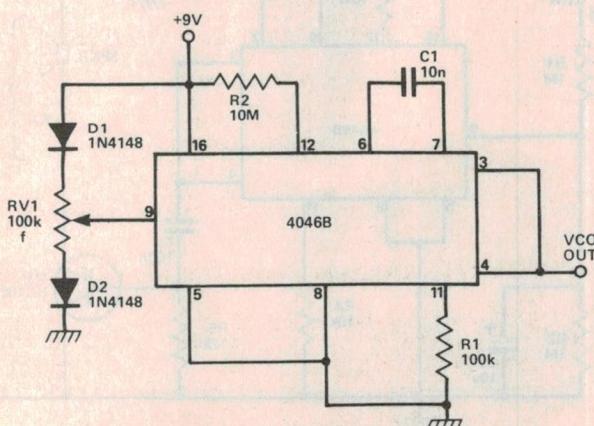


Figure 4. Wide range VCO with frequency variable down to absolute zero.

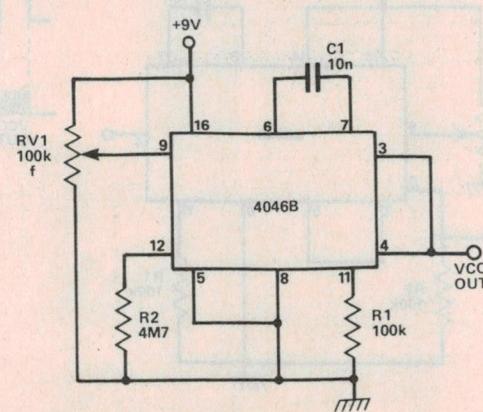


Figure 5. Restricted range VCO with frequency variable from 60 Hz to 1.4 kHz by RV1. R2 acts as an offset resistor.

# Lab Notes

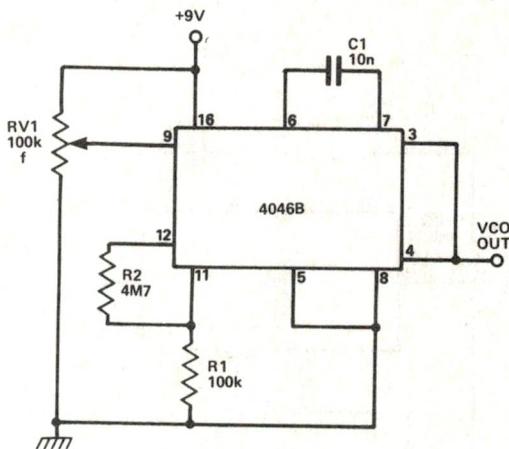


Figure 6. An alternative restricted range VCO, in which  $f_{\max}$  is controlled by  $R1-C1$  and  $f_{\min}$  by  $(R1 + R2)-C1$ .

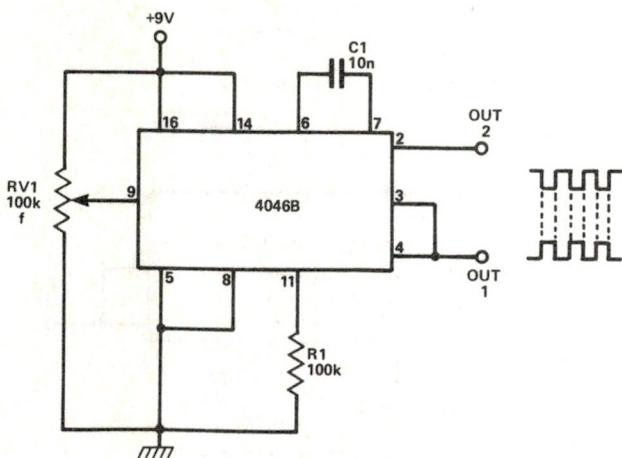


Figure 7. A two-phase wide-range VCO.

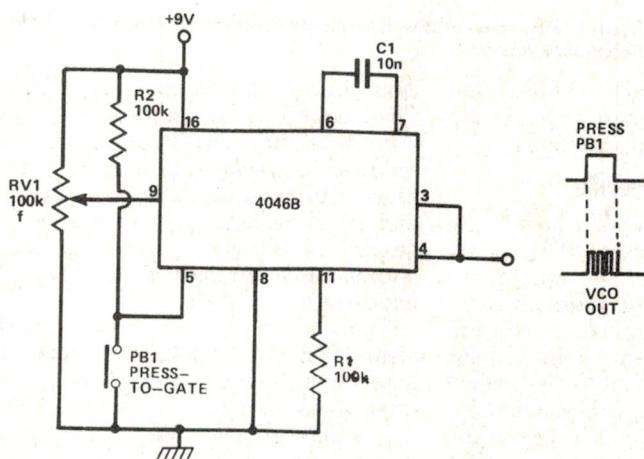


Figure 8. A manually gated wide-range VCO.

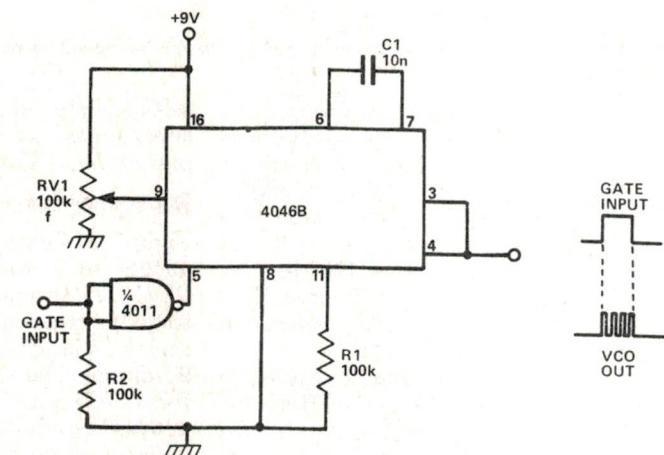


Figure 9. An electronically gated wide-range VCO, using an external gate inverter.

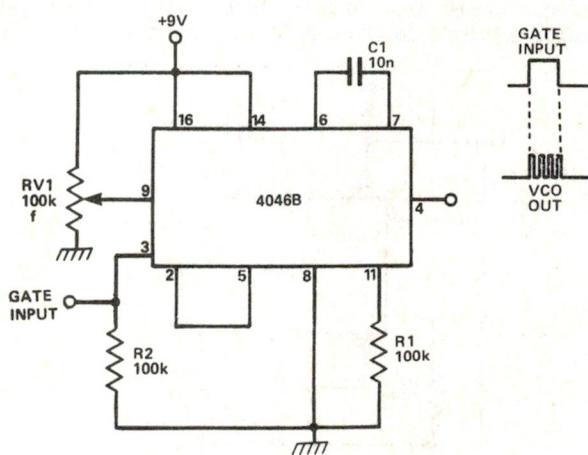


Figure 10. An electronically gated wide-range VCO using the internal EX-OR phase detector for gate inversion.

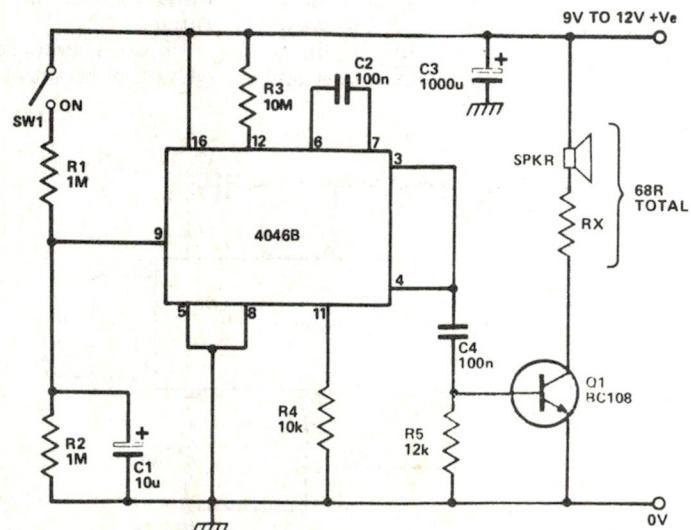


Figure 11. An electronic siren giving slow rise and fall of its operating frequency.

bination of R1 and R2. Note that, by suitable choice of the R1 and R2 values, the restricted-range VCO can be made to span any range from 1:1 to near infinity.

### Square pair

The VCO can be made to generate a pair of anti-phase square wave outputs by connecting its output to the phase-comparator input, taking the signal input (pin 14) high and taking the anti-phase output from pin 2. Figure 7 shows the connections. Note that this circuit makes use of the IC's built-in EX-OR gate (phase comparator 1).

The VCO section of the 4046B can be disabled by taking pin 5 of the package high (to logic level 1). This feature enables the VCO to be gated on and off by external signals. Figure 8 shows how the VCO can be manually gated via a pushbutton connected directly to pin 5, while Figure 9 shows how the circuit can be gated electronically by an external gate inverter. Alternatively, if the two-phase output facility is not required, the internal EX-OR phase detector can be used to provide gate inversion, as shown in Figure 10. Note in this latter case that pin 4 is not connected to pin 3.

### Sirens and sound effects

Figures 11 to 14 show some practical siren and sound effects generator VCO circuits. Figure 11 is a conventional siren circuit. When SW1 is closed, C1 charges exponentially via R1 and the VCO frequency rises slowly from zero to a maximum value. When SW1 is

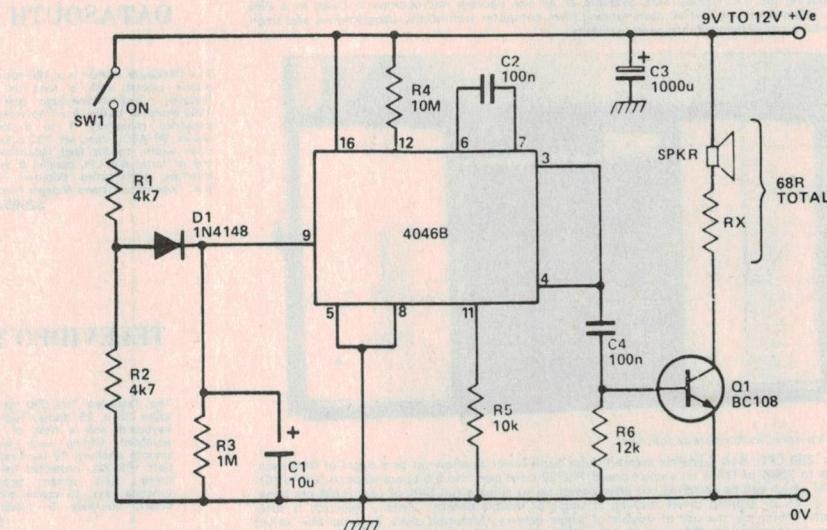


Figure 12. This quick-start siren gives a rapid rise and slow fall of its operating frequency.

opened, C1 discharges via R2 and the operating frequency slowly decays to zero. The VCO output is ac-coupled to the speaker via C4 and Q1.

The Figure 12 quick-start siren is similar to the above, except that C1 charges rapidly to half supply volts via R1, R2 and D1 when SW1 is closed and discharges slowly via R3 when SW1 is opened.

The Figure 13 circuit produces a 'phaser' sound when PB1 is closed. The 4011 astable is gated by PB1 and produces a chain of 4 ms pulses at intervals of 70 ms. Each pulse rapidly charges C2 via R3 and D2, to produce a high tone that then decays rapidly as C2 discharges via R5, only to be repeated again on the arrival of the next pulse.

The Figure 14 circuit generates

either a pulsed tone or a warble tone signal (depending on the setting of SW1) when PB1 is closed. PB1 is used both to enable pin 5 of the 4046B and to gate on the 4001 astable, which then applies a rectangular (alternatively fully high and fully low) waveform to pin 9. In the pulsed mode the VCO generates zero frequency when pin 9 is low. In the warble mode it generates a tone that is 20% down on the high tone when pin 9 is low.

### Miscellaneous VCO circuits

Figures 15 to 17 show a miscellany of 4046B VCO circuits. The Figure 15 circuit is that of an FSK generator which produces a 2.4 kHz tone when a logic 1 signal is applied to pin 9 and a 1.2 kHz tone when a logic 0 signal is ▶

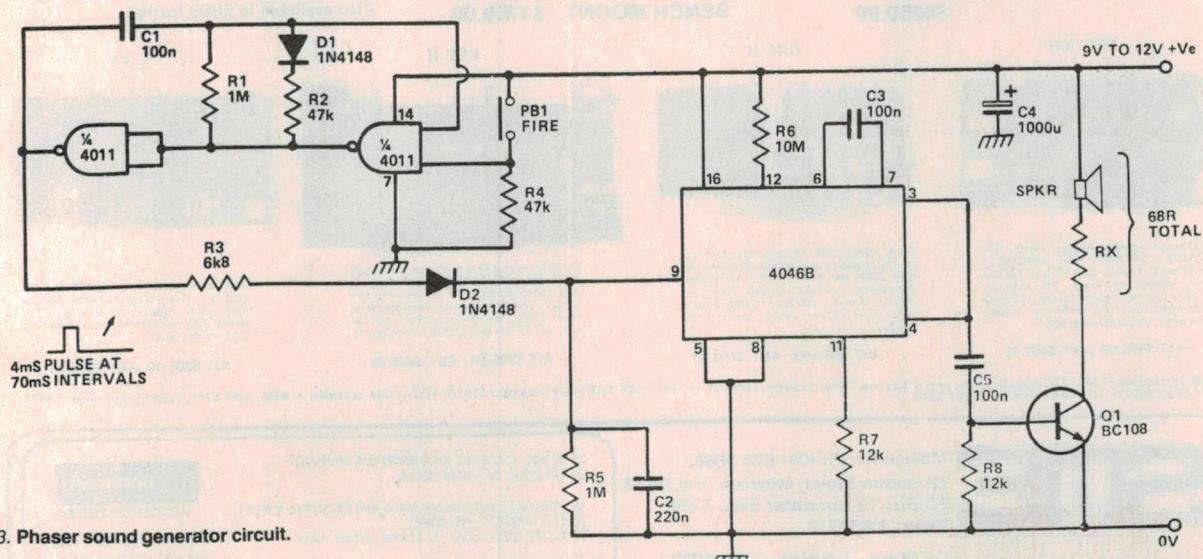
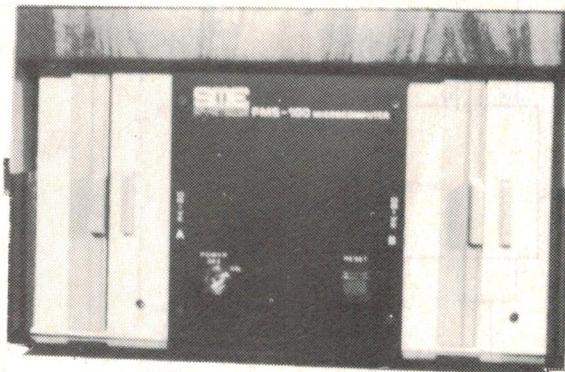


Figure 13. Phaser sound generator circuit.

# S100-Z80 MICROCOMPUTERS

PMS100

Introducing the PMS100 by SME Systems, an all new package microcomputer based on a Z80 CPU. This system will suit all users ranging from computer technicians, programmers and small to medium company accounting requirements.



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4 Mhz Z80 CPU, 64K Dynamic memory with bank select to allow up to 8 pages of 64K each, and up to 256K of RAM on a single board, RS232 serial port and 8 bit parallel ports. Up to 16K EPROM which can be switched out after power up to allow a full 64K of user RAM per bank. Dual QUME 8" d/sided drives running at single or double density. Density selection is automatically chosen by the use of double or single density formatted disks. External Mini drives can also be interfaced to the controller. The DOS supplied is compatible with standard CP/M and CDS to allow a wide selection of software to be used, such as MBASIC, CBASIC, COBOL, ALGOL, PASCAL, FORTRAN, ASSEMBLY LANGUAGE, WORD PROCESSING, MULTI-USER, MULTITASKING, AND ACCOUNTING PACKAGES. All of which can be supplied from SME Systems.

The PMS100 is AUSTRALIAN designed and built and can be supplied as a basic system or as a complete turnkey system including terminal, printer and software.

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This is the way to bring mainframe storage to the micro's. It allows hard disk advantages with built in back up. We have software & hardware to interface to S100, Apple & Tandy systems. Easy to install & operate, removable media, built in 512 byte buffer, high speed LSI controller, can daisy chain up to 4 drives.

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SBC-400

## DUAL 8" DRIVE



A new product from SME is a dual drive package available in a bench mount or rack mount style. It uses dual 8" double sided, double density compatible drives, in a low profile cabinet. Built in power supply, line filter & cooling fan. Drive interface is via a 50 way centronic type connector. This unit is supplied assembled & tested.

RACK MOUNT \$1800.00  
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R/M KIT \$325.00  
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Available in rack mount or bench mount. Built in power supply 8v @ 15 amps + & - 16v @ 2 amps, key switch, reset switch, fan cooled power supply, 11 slot mother board, supplied with 5-S100 edge connectors, all power supply rails are fuse protected. Also available in 6800 format.

SPC-29



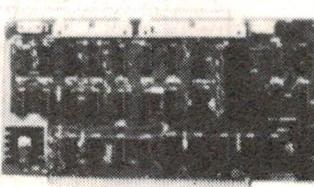
Z80 single board computer, 4MHz, 16K EPROM, 16K RAM, 16K EPROM, 1 serial port, 1 input & 1 output parallel port, power on jump, 2K monitor, 2716 4 channel counter/timer, software controlled baud rate generator, modem look alike, vectored interrupt.

KIT \$395.00 A&T \$465.00



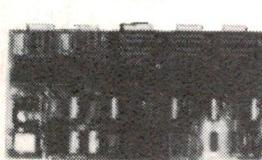
Bank select, 200 nS chips standard up to 4MHz speed, will accept 64K rams to give 256K per board, switch selectable boundaries, invisible refresh, phantom output disable, standard S100 plated thru holes, solder resist, components overlay.

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Operates with single & double den, single & double sided drives & 8" or 5" drives in any combination of 4 drives simultaneously, phase lock loop data recovery, with SDOS operating system you can run all CP/M and CDS programmes.

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# Lab Notes

Figure 14. Combined pulsed tone/warble tone alarm generator. The high tone is determined by R3, the low tone by (R3+R4).

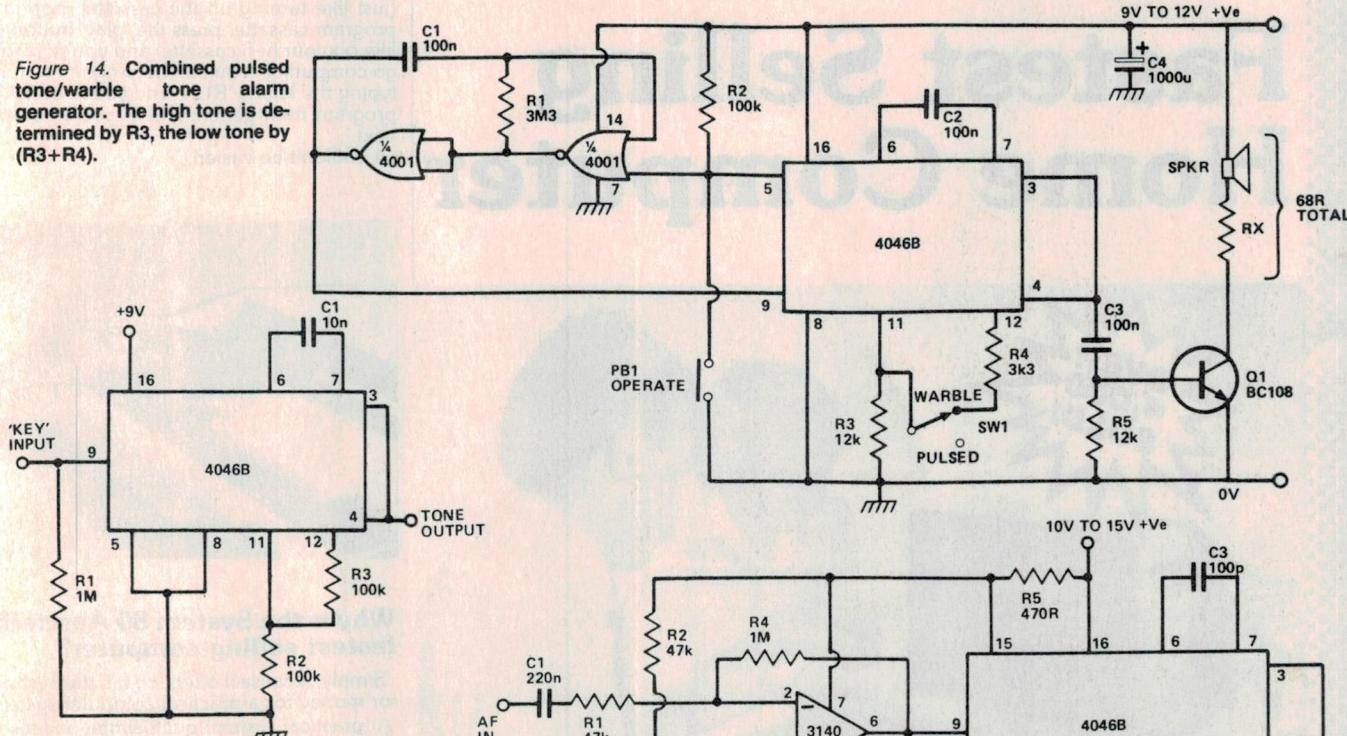


Figure 15. FSK generator — logic 0=1.2 kHz, logic 1=2.4 kHz.

applied. The high tone is controlled by R2 and the low tone by R2 and R3.

Figure 16 is a 220 kHz FM generator. The internal zener of the 4046B (pin 15) is used to provide a stable 7 V supply to the x20 3140 inverting amplifier, which is quiescently biased at 3.5 V by the R2-R3 potential divider. The pin 9 VCO signal is thus a mean 3.5 V potential amplitude modulated by an amplified version of the AF input signal, which thus frequency-modulates the output of the VCO.

## Running down

The Figure 17 circuit is that of a run-down clock generator of the type used in dice and roulette games. When PB1 is pressed, C1 charges to a high voltage via D2. Simultaneously, Q1 is biased on via D3-D4 and effectively connects R6 between pin 11 and ground. Under this condition, the VCO operates a high frequency (tens of kHz) and effectively generates a random number of clock pulses. When PB1 is released, Q1 turns off and the VCO timing is governed by R8. Simultaneously, C1 rapidly discharges to half supply volts via R1-R2-D1, so the VCO operates at only 100 Hz or so. C1 then slowly discharges via R3 and the VCO frequency slowly decays to zero over a period of about 15 seconds. ●

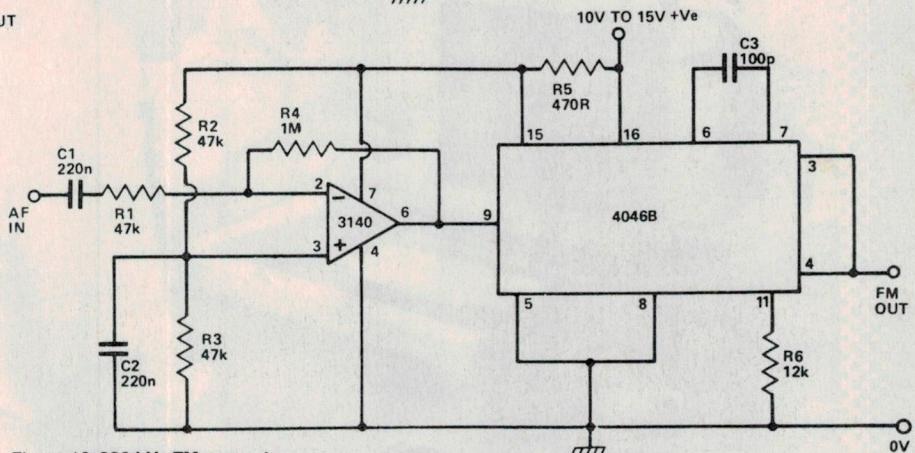


Figure 16. 220 kHz FM generator.

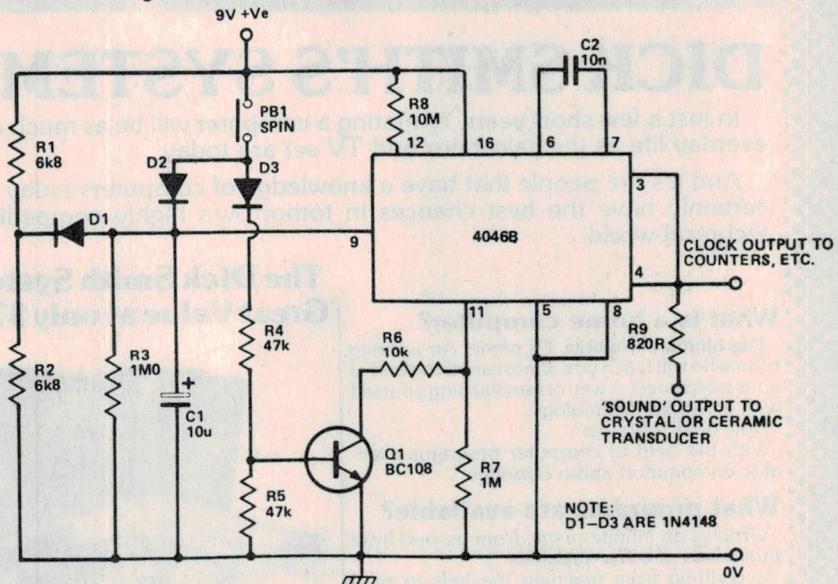


Figure 17. Run-down clock/sound generator for use in dice/roulette games. The circuit is suitable for use with edge-sensitive clock circuits only. The output can be used to directly clock most types of counter and can be fed, via R9, to crystal or ceramic transducers to directly produce 'run down' sounds. When the run-down is complete this circuit may settle in either logic 0 or 1, so it cannot safely be used to clock level-sensitive circuitry.

# Australia's Fastest Selling Home Computer



## DICK SMITH'S SYSTEM 80

In just a few short years, operating a computer will be as much a part of everyday life as the calculator and TV set are today.

And it's the people that have a knowledge of computers today that will certainly have the best chances in tomorrow's highly competitive and technical world.

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And, as we said before, once you understand your computer, you'll be able to write your own programs to do just what YOU want to do!

### The Dick Smith System 80. Great Value at only \$750.00



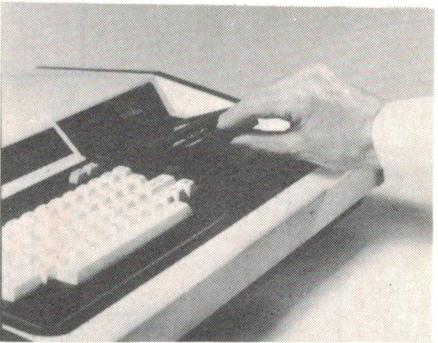
This is just a sample of the wide range of software available for use on your System 80.

### Are they difficult to use?

Lets answer that question by asking you a question: Do you use a cassette recorder in your home?

The Dick Smith System 80 home computer is just as easy to use. You turn the computer on (just like turning on the cassette), pop in the program cassette, press the 'play' button (just like on your hi-fi cassette) and you're ready to go computing. You tell the program to run by typing the letters 'RUN' and you're away! The program itself generally tells you what to do next.

It couldn't be easier!



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A 'practical system' quite simply means one that **you** can use (and that includes program availability).

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Some computers are being offered as various bits and pieces. This is quite okay: as long as you understand what you are buying! The System 80 computer, as it comes to you, is a fully operational computer. You don't need to buy another thing to make it work: plug it in to a TV set and a power point - and it works.

Many other computers are little more than fancy plastic boxes: until you start buying the 'add-ons' to make them work, they're not much use to you.

Beware of seemingly attractive 'computer only' prices. Make sure you take into account the 'add-ons'!

### And it's over \$500 cheaper than the Tandy TRS-80!

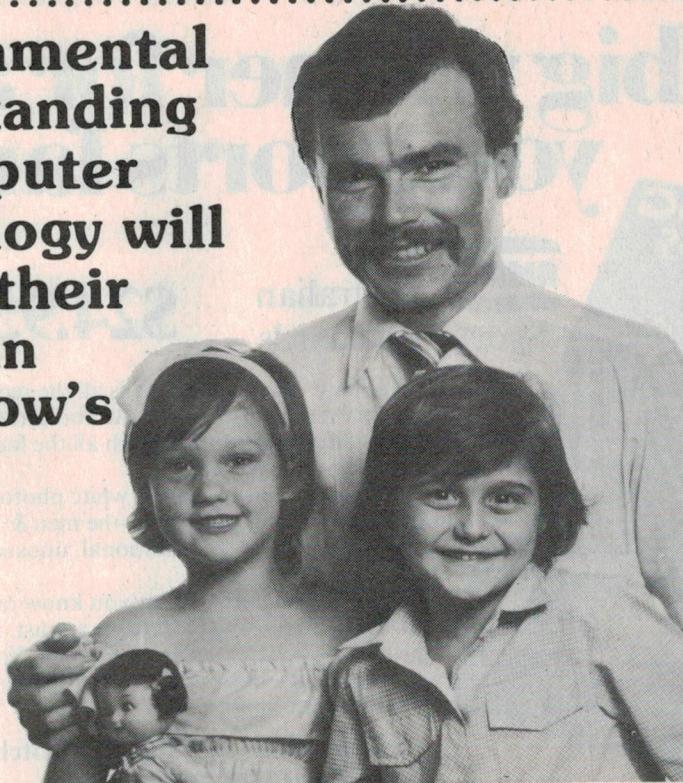
If you buy the Dick Smith System 80, you'll save over \$500 on the current Tandy computer.

The closest equivalent current model Tandy Computer is the TRS-80 model III, with 16K of memory, monitor, but no cassette recorder. Add a cassette recorder and the system sells for over \$1450. We do not compare the System 80 against the TRS-80 model I as it has been discontinued in the USA, the country of manufacture and no longer sold here.

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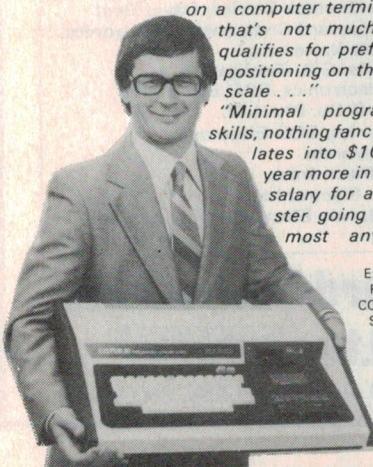
## \*Read what a leading US magazine says:

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Extract from  
PERSONAL COMPUTING  
September, 1981



## This is a list of private companies and Government departments who have chosen the System 80 computer above other brands.

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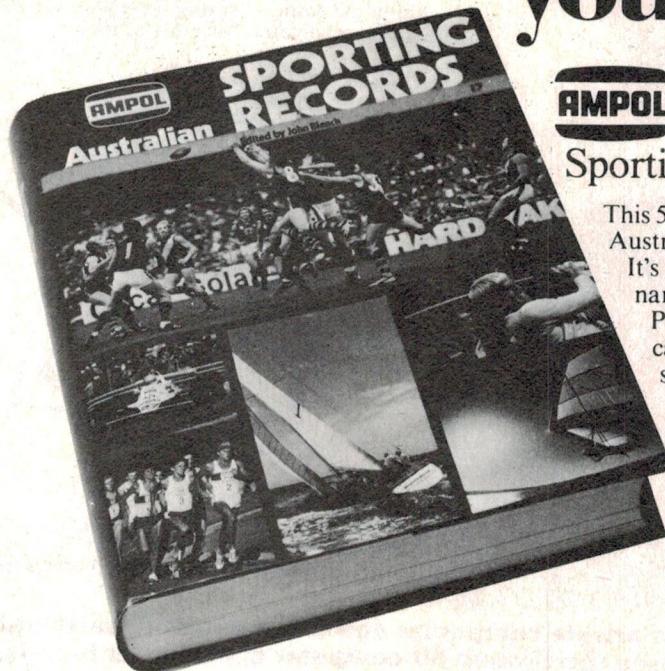
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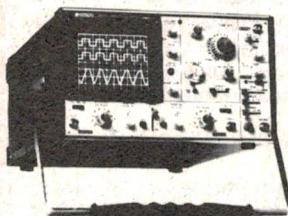
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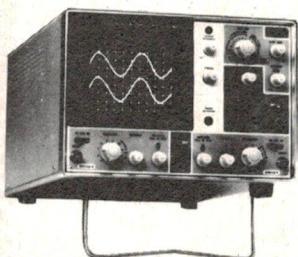
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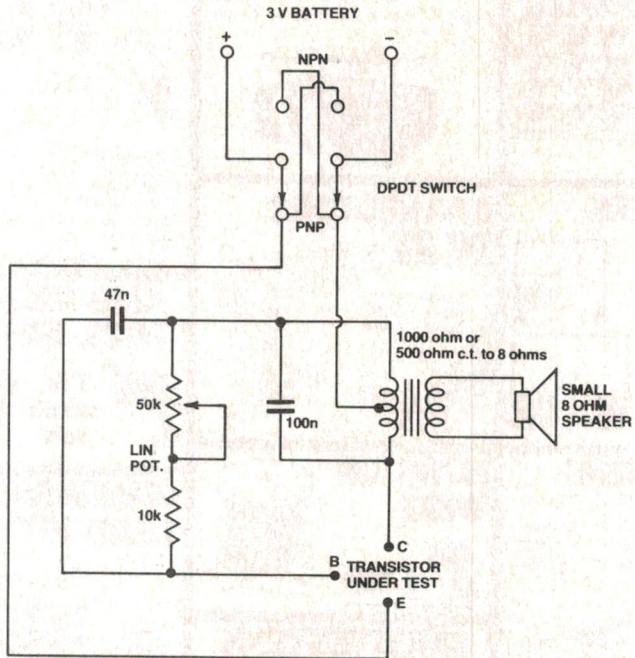
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# Ideas for Experimenters

These pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory. Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we produce constructional details.



## Quick transistor checker

This simple little circuit is quite effective for testing bipolar transistors, being a favourite of **Agostino Greco of Clayton in Victoria**, who has used it over the last few years.

The circuit is a basic Hartley oscillator using a centre-tapped audio output transformer of the type commonly found in small transistor

radios, driving a small 8 ohm speaker. The latter is a common item, stocked by many suppliers, or you can salvage one from a defunct transistor radio. You could salvage a suitable transformer from a defunct radio also, or you could obtain one of the models stocked by Tandy (catalogue No. 273-1380) or Dick Smith (catalogue No. M-0216).

A 50k potentiometer provides a means of varying the tone of the

oscillator, from a low frequency at high values of resistance to higher frequencies at lower values of resistance. The series resistor is provided to limit the high frequency range, as otherwise the circuit may cut off, depending on the particular transistor being tested, and further to limit the maximum current drawn by the circuit to a value well under 50 mA at full setting of the potentiometer.

The two capacitors are in no way critical and serve to set the frequency of operation of the oscillator. They have been chosen to give a pleasing tone with a 50k potentiometer. Increasing the value of either capacitor will result in a decrease in the frequency of the oscillator.

In use, the transistor to be tested is connected to the circuit via crocodile clips. If there is no response from the circuit, then the polarity change switch should be toggled, and hopefully there will now be a tone output from the speaker. If there is no result with the switch in either position, then the device is faulty; alternatively it may be an FET, UJT or SCR, etc, type device, in which case this tester will be of no use.

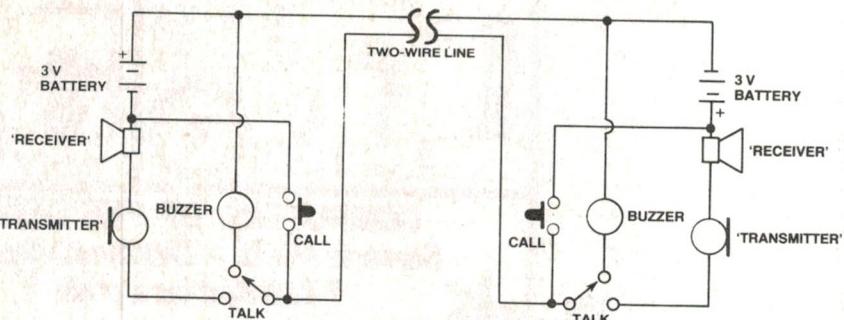
Note that there will be no harm done to a transistor if it is initially connected up to the circuit with the polarity switch in the wrong position, as it will be reverse biased and hence will draw only small leakage currents.

## The simplest intercom

This is just about the simplest intercom one could devise, according to **David Timmins of Pullenvale in Queensland**. Its big advantage is that only a two-wire line is required.

The 'receiver' and 'transmitter' may be salvaged from 'surplus' telephone handsets. The transmitter unit is a carbon microphone and the receiver unit is a rocking armature earpiece. Any of the small electronic or electro-mechanical buzzers available may be pressed into service. Dick Smith stocks one, catalogue No. L-7009, while Tandy

list several suitable types, such as catalogue Nos. 273-004 or 273-060. Pressing either 'call' button will sound both buzzers.



Each 'talk' switch should be a spring return-type. If you can arrange to hang the handset off them, so much the better.

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# "Heads or tails"—electronic decision maker!

THIS SIMPLE novelty circuit is designed to electronically simulate the tossing of a coin; randomly producing a 'heads' or 'tails' output. The output of the unit is displayed on two LEDs, one being marked 'heads', and the other being given a 'tails' legend. The unit has a pushbutton switch which is briefly pressed in order to 'toss the coin', and only one of the LEDs will be switched on when this switch is released, indicating the 'decision' of the unit.

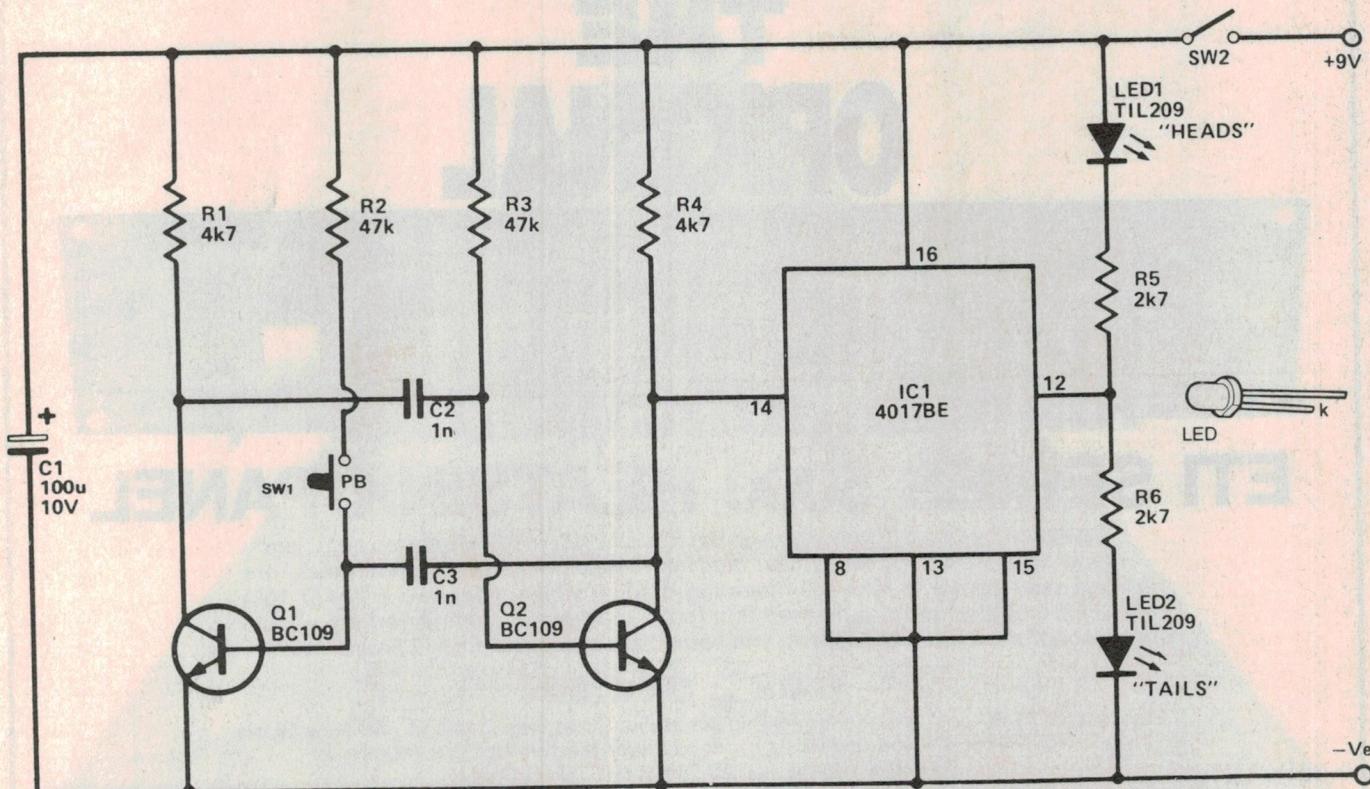
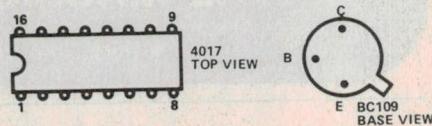
The circuit uses Q1 and Q2 in what is virtually a standard astable multivibrator circuit. The only deviation from the standard configuration is the inclusion of pushbutton switch SW1 in the bias circuit for Q1. As the circuit stands there is no bias to Q1, and the circuit therefore fails to oscillate. However, if SW1 is operated the circuit can function normally. A roughly square

wave output is then produced at the collector of Q2, and the specified values give an operating frequency of many kilohertz.

This square wave output is fed to a 4017 divide-by-ten circuit, which is used here effectively as a form of bistable circuit. After each five input cycles, the output of IC1 (pin 12) changes state, and while the clock oscillator is functioning, this output therefore changes state a few thousand times per second. LED1 and LED2 are the two indicators, and are driven from the output of IC1 via current-limiting resistors R5 and R6. When IC1's output is low, R6 and D2 are effectively short circuited by the output stage, but D1 will be switched on. Conversely, when the output is high D1 and R5 are short circuited, and it is D2 that is switched on. While the oscillator is running, both

LEDs appear to be switched on since the switching action is far too rapid for a human observer to perceive. When SW1 is released and the oscillator stops, IC1 will stay in whatever output state it happened to have at the instant the oscillator stopped. There is, of course, no way of predicting which state this will be, and which of the LEDs will be switched on. It is purely a matter of chance whether the unit indicates 'heads' or 'tails'.

SW2 is the on/off switch. The current consumption of the circuit is only about 5 mA.



# "Audio-Technica have always made good tonearms — but this one beats the lot!"

— Cliff Wilson  
Popular Hi-Fi London



## Audio Technica AT 1100 arm.

AT-1100 is a new low-mass tonearm with a plug-in, integrated arm. Precision fabricated, main features include extremely low-mass, immunity to resonance, and damping to reduce IM distortion and enable high trackability. AT engineers determined that tonearm f0 — the fundamental resonance inherent in any tonearm — should be around 10 Hz. At a lower f0 of 4 to 6 Hz, such as is characteristic of conventional tonearms, the tonearm easily picks up record warp and motor rumble. At a higher f0 of 20 Hz, the tonearm becomes susceptible to ambient vibrations from the cabinet. When the AT-1100 is used with a typical high compliance cartridge, the f0 lies at an optimal 10 Hz. A unique dashpot damps abnormal lateral arm motion and reduces f0 amplitude by 8 dB. Unusual features include the integrated tonearm which eliminates connector ring resonance and weight. All electrical contacts are gold-plated. The machined aluminium head shell weighs only 3 grams, and the pipe 6.5 grams. To further reduce weight, the counterweight mass is concentrated in one small area along the tonearm axis. The extra-rigid pipe is heat-hardened aluminium alloy. Computer type silver lead wires use teflon insulation for efficient transmission of high frequencies. This superflexible lead wire also allows free movement of the tonearm and has micro-polished ball bearings which eliminate play and ensure accurate alignment. Anti-skating compensation provides adjustment for elliptical, line contact and spherical stylus. An oil damped lever assures smooth cueing. Distinctive in profile, the AT-1100 uses the Dynamic Tracing System to place the tonearm pivot at the same level as the stylus for stable tracing even at high amplitudes.

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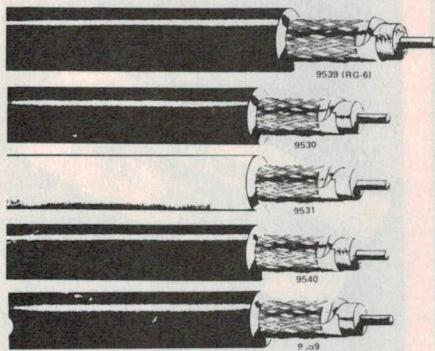
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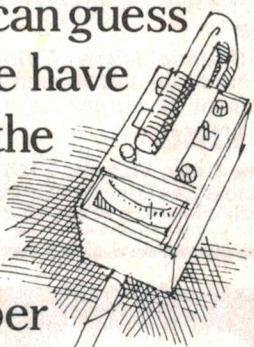
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		TNB TYP at 1kHz	IMD 60Hz/ 7kHz 4:1	
HY30	15w/4.8Ω	0.015%	<0.006%	± 18 ± 20
HY60	30w/4.8Ω	0.015%	<0.006%	± 25 ± 30
HY120	60w/4.8Ω	0.01%	<0.006%	± 35 ± 40
HY120P	60w/4.8Ω	0.01%	<0.006%	± 45 ± 50
HY200	120w/4.8Ω	0.01%	<0.006%	± 45 ± 50
HY200P	120w/4.8Ω	0.01%	<0.006%	± 45 ± 50
HY400	240w/4. Ω	0.01%	<0.006%	± 45 ± 50
HY400P	240w/4. Ω	0.01%	<0.006%	± 45 ± 50

## HEAVY DUTY

HD120	60w/4.8Ω	0.01%	0.006%	± 35 ± 40
HD120P	60w/4.8Ω	0.01%	0.006%	± 45 ± 50
HD200	120w/4.8Ω	0.01%	0.006%	± 45 ± 50
HD200P	120w/4.8Ω	0.01%	0.006%	± 45 ± 50
HD400	240w/4. Ω	0.01%	0.006%	± 45 ± 50
HD400P	240w/4. Ω	0.01%	0.006%	± 45 ± 50

## MOSFET

MOS120	60w/4.8Ω	0.005%	0.006%	± 45 ± 50
MOS120P	60w/4.8Ω	0.005%	0.006%	± 55 ± 60
MOS200	120w/4.8Ω	0.005%	0.006%	± 55 ± 60
MOS200P	120w/4.8Ω	0.005%	0.006%	± 55 ± 60
MOS400	240w/4. Ω	0.005%	0.006%	± 55 ± 60
MOS400P	240w/4. Ω	0.005%	0.006%	± 55 ± 60

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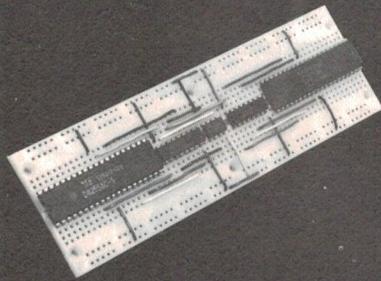
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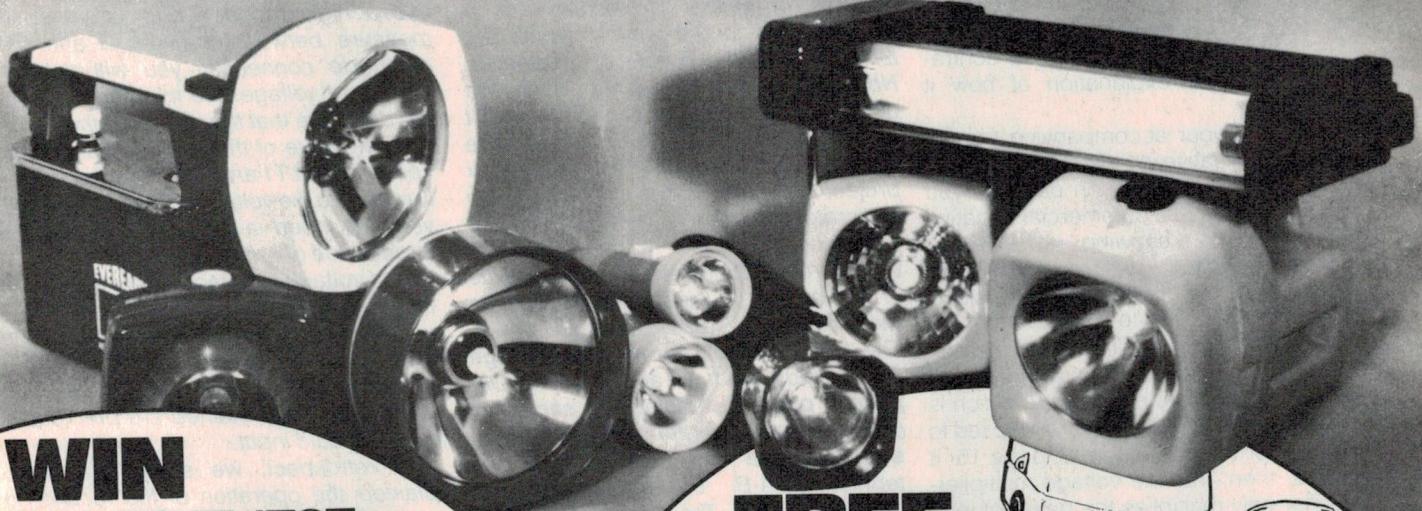
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TOP 781/2 - B&W

# LETTERS

Dear Sir,

I think there is an error in the design of the ETI-1501 Negative Ion Generator (April '81, p. 30), or at least a contradiction in your explanation of how it works.

Firstly, in your accompanying feature article on negative ion generators (pages 15 to 21, same issue), on page 17 you give the circuit of a commercial negative ion generator, showing a 10-stage 'Cockcroft-Walton' voltage multiplier-rectifier which works on the principle of multiplying the peak-to-peak value of the ac mains input. As the peak-to-peak value of the mains is about 680 V, the rectifier would give nearly 7 kV, which is nothing like the 3 kV you say is applied to the emitter head in Figure 2, page 16. It seems, then, that the voltage multiplier-rectifier only multiplies the peak value of the input.

Looking at the ETI-1501 project, the circuit on page 31 shows the same sort of rectifier, only it has six diodes, not ten. It should only produce about 1.8 kV. On my unit, which I built from a kit, I can measure about 1 kV with my multimeter. Taking into account the loading effects, this seems to confirm my suspicion that the rectifier in the project only produces 1.8 kV.

I looked up the rectifier circuit in a textbook, which says that it multiplies the peak of the ac input voltage, and I asked my electronics lecturer at tech. and he says there seem to be insufficient diodes on the high voltage board of the ETI-1501 to produce the voltage specified (3 kV).

How do you get 3 kV? Can you enlighten me?

W. Dillon  
Melbourne, Vic.

*There is neither a mistake nor a contradiction in the way in which the ETI-1501 works and how it is explained. However, there is some confusion arising, as you are comparing the circuit of the commercial ion generator on page 17 of the April issue with the circuit of our project on page 31. The commercial ion generator employs a voltage multiplier driven by a sinusoid — the mains. This type of rectifier multiplies the peak value of the ac input. The peak value of the (nominal) 240 V mains is about 340 V. The 10-stage multiplier rectifier on page 17 will thus produce about 3.4 kV. Our project, page 31, employs the same sort of rectifier-multiplier, but it is driven by a square wave (1:1 duty cycle) from terminals A-B of the transformer secondary (T1). The peak value of the square wave at A-B is about 600 V. Thus the six-stage Cockcroft-Walton rectifier-multiplier produces around 3-3.5 kV. The proof of this is in the measurement. If you*

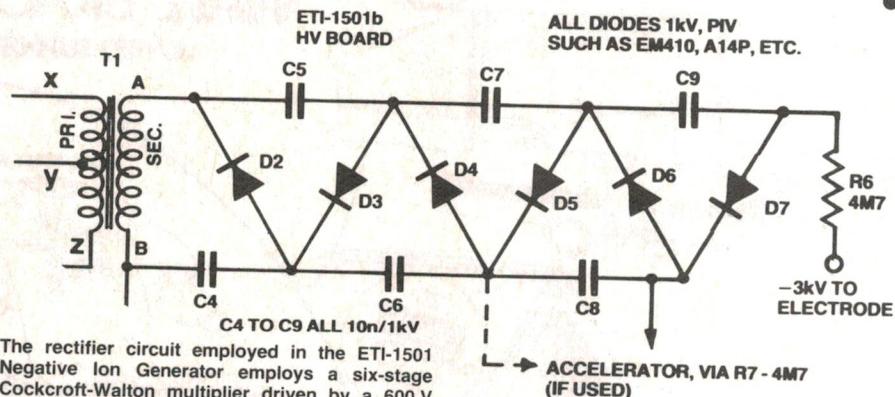
use a high impedance input meter to measure between terminal B and the electrode connection you will get the predicted voltage. We measured it, and we did. Note that the peak and the peak-to-peak value of the square wave at the secondary of T1 are the same. To properly measure the voltage at the anode of D7 you will need a meter with an input impedance of at least 10 M.

The voltages quoted are not specifications but measurements.

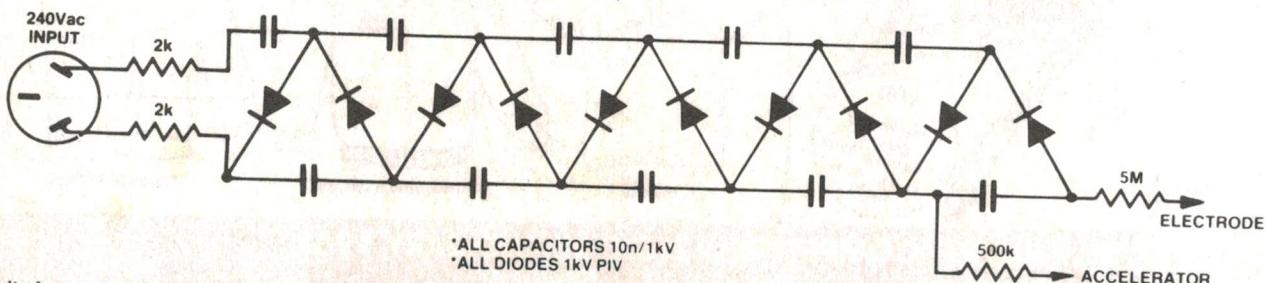
Most texts, when explaining the operation of voltage multipliers (and rectifiers for that matter) fail to mention that the results obtained are predicated on a sinusoid input.

In retrospect, we should have explained the operation of the rectifier in more detail, as it is employed here in an unusual application and a number of readers wrote puzzling about it in the same way you did. I trust you have now learned a little more about electronics.

Roger Harrison  
Editor ETI



The rectifier circuit employed in the ETI-1501 Negative Ion Generator employs a six-stage Cockcroft-Walton multiplier driven by a 600 V peak square wave, producing around 3-3.5 kV (page 31, April '81 ETI).



Circuit of a commercial negative ion generator (ETI April '81, Figure 3, p.17). This is driven by the 240 Vac mains, a sinusoid with a peak value of about 340 V, the ten-stage Cockcroft-Walton multiplier producing about 3.4 kV.

# AMPLIFIER SENSATIONS!

Even our jaded and cynical staff are amazed. We have been absolutely swamped with orders for the new ETI 5000 Pre-amp and Power Amp.

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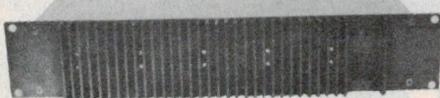
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Ref: ETI Jan — April 1981



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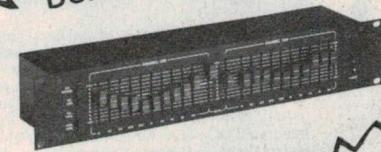
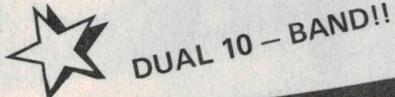
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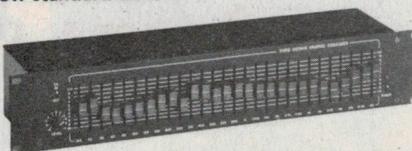
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**Sansui**

# LETTERS

Dear Sir,

Could you please supply circuits for the following: 240 V mains electric fence and a portable cattle prod. I understand that you are not responsible for their construction and any information that you supply would not obligate you in any way.

J. Adams,  
Sheffield, Tasmania.

*Unfortunately, we cannot undertake to supply information or circuits on equipment or projects other than what we have published in the magazine. We trust that you, and other readers, would understand that our technical staff is primarily occupied on research, development and production of projects and technical articles for publication in the magazine and we cannot afford to seek out or develop circuits from other sources for individuals' applications.*

Roger Harrison  
Editor, ETI

Dear Sirs,

Could you please advise if you ever published information about using the **ETI-681 Programmable Character Generator** as an (x, y) graphics plotter? One paragraph in the original construction article (ETI June 1980, p.67) said "... more about this later ...", but the article stopped at only describing the hardware.

I have been thinking about ways of using it to achieve (x, y) plotting and vector graphic drawing ((a, b) to (x, y)) but do not have the hardware on which to experiment yet. In fact I want to feel reasonably sure it will do what I want before I start assembling an S100 system based on the ETI/DGZ80 + 640.

My approach is to work up a machine language routine to convert the (x, y) co-ordinates to (CHR, LINE, column, row) co-ordinates to specify which 'character' and which dot, then check the 'characters' already programmed to see if one fills the bill, and if so to address the relevant VDU RAM cell to it, or if not to program a new one and address the VDU cell to it. I haven't figured out a way to do the vector graphics yet. I'm hoping you have done some work on it as I would hate to tax my brain duplicating someone else's headaches!

An incidental enquiry: I have not yet been able to get a clear statement from a kit supplier as to whether the **DGZ80** will operate **dynamic memory** boards such as the TCT. The description in the original article does not touch the subject. Can you say yea or nay?

Many thanks for a continuing stream of interesting material in your magazine.

G.N. Harrod  
Indooroopilly, Qld.

We have spoken with Craig Barrett, designer of the ETI-681 PCG concerning follow-up articles on using this versatile S100 board, and he is preparing article(s) which we hope to publish early next year.

There is no ostensible reason why the ETI-680 (DGZ80) S100 CPU board cannot be used with a suitable S100 dynamic RAM card.

Dear Roger,

I wish to take this opportunity to congratulate you on your excellent article, "A good joint is hard to find ...".

Whilst many of the experienced readers may think that this subject is 'done to death', we here at Jaycar feel that not enough attention is paid to soldering by the average enthusiast. Despite years of practice most people still regularly produce dry joints. As a matter of fact, 90% of the faults in correctly wired kits (in our opinion) are due to poor solder joints.

Perhaps as a follow-up to this article you could do a small article on the art of correctly soldering and terminating screened audio cable. With the tremendous interest in the Series 5000 preamp we feel that such an article would be certainly justified!

Finally on another note, I thoroughly endorse the comments you made in your editorial in the October issue. Tax on most hobby electronic components is now a staggering 30%, thanks to the latest budget. Inevitably these increases will pass on to the hobbyist. As you said, the cost of interest in electronics will rise, thus dampening motivation. I should have thought the Government would have encouraged motivation (especially in young people), not discouraged it.

G.N. Johnston  
Managing Director, Jaycar

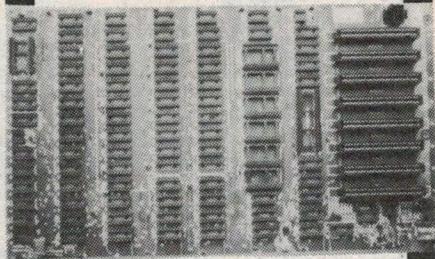
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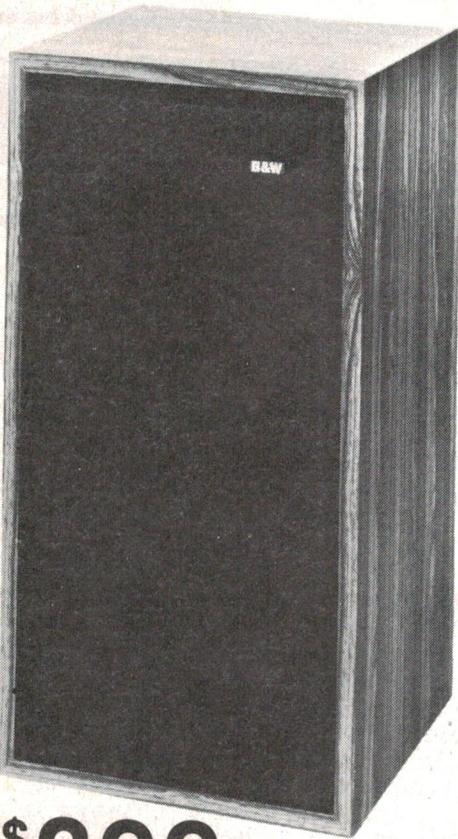
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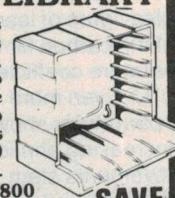
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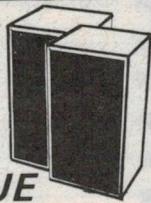
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PAIR!**



**TOP  
VALUE**

Impressive speakers at a bargain price! Rated at 8 ohms impedance, 15 w.p.c. Why not buy a pair for the patio or rumpus room and have music all over the house!

**Extension  
speakers**  
**\$39.95**  
Cat. A-2460  
**SOUND  
VALUE!**

Good quality cassette tape, at a lower price. Even greater savings if you buy 10 or more!

**C60 Low Noise**  
Cat. C-3350 \$1.50  
10 UP \$1.00

**C90 Low Noise**  
Cat. C-3352 \$2.00  
10 UP \$1.20

**C90 Extended Dynamic Range**  
Cat. C-3354 \$2.75  
10 UP \$1.90  
**SOUND VALUE!**

**SALE PRICES EXPIRE  
DECEMBER 31st**



welcome here

# DICK SMITH'S SOUND VALUE!



**TOP  
VALUE** ~~\$72.00~~

### HI-FI STAND

A beautifully prepared kit cabinet, comes to you in knock-down form and complete with full instructions for easy assembly. Finished size: 370mm (d) x 470 (w) x 940mm (h). Wood grain finish. Cat. A-0105

**SOUND  
VALUE!** ~~\$64.80~~  
SAVE 10%

### TOP VALUE! SHURE MAGNETIC CARTRIDGES

#### Model M-91ED

The Shure M-91ED is a first class magnetic cartridge. It has high trackability with a recommended tracking weight of between  $\frac{3}{4}$  and  $\frac{1}{2}$  grams. Complete with elliptical diamond stylus. Cat. C-5515

**\$49.00**

#### Model M-70EJ

This cartridge has a tracking weight of  $\frac{1}{2}$  to 3 grams and a frequency response of 20 - 20,000Hz. Complete with elliptical stylus. Cat. C-5512

**\$18.50**

#### Model M-70B

The same superb specifications as the M-70EJ but has a spherical diamond stylus. The same stylus is supplied with the Dick Smith turntable.

Cat. C-5511 **\$13.50**

#### Replacement Stylus

for the M-91ED cartridge. Cat. C-5036

**\$19.95**

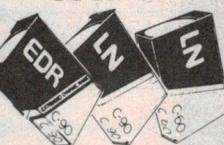
for the M-70EJ cartridge. Cat. C-5034

**\$14.50**

for the M-70B cartridge. Cat. C-5032

**\$9.95**

### DICK'S OWN QUALITY TAPE



Good quality cassette tape, at a lower price. Even greater savings if you buy 10 or more!

**C60 Low Noise**  
Cat. C-3350 \$1.50  
10 UP \$1.00

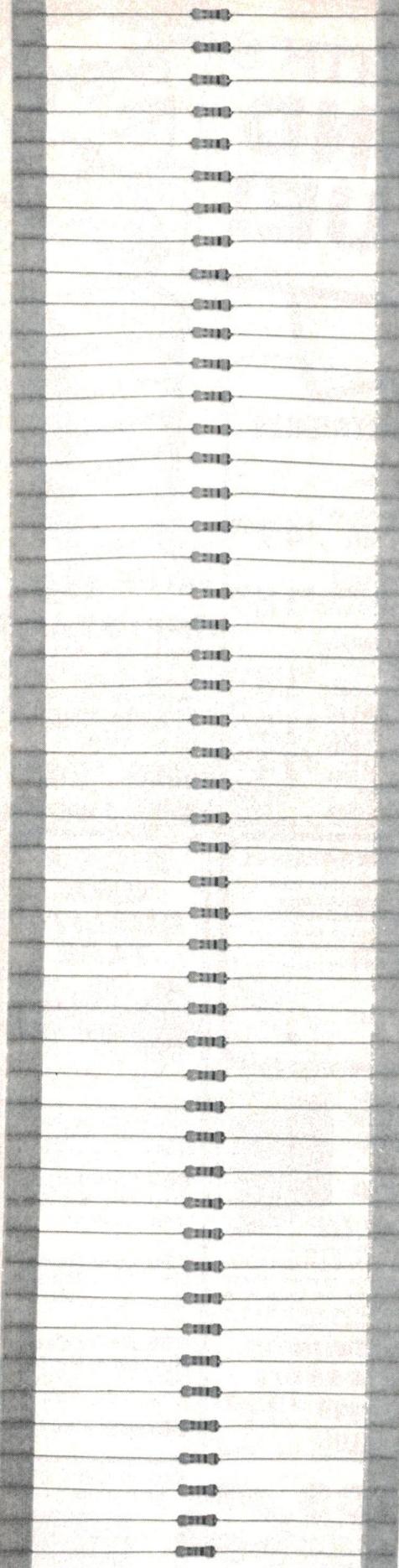
**C90 Low Noise**  
Cat. C-3352 \$2.00  
10 UP \$1.20

**C90 Extended Dynamic Range**  
Cat. C-3354 \$2.75  
10 UP \$1.90  
**SOUND VALUE!**

**DICK SMITH Electronics**

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• 842 Gympie Rd CHERMSIDE 59 6255 SA 60 Wright St ADELAIDE 212 1962 VIC 399 Lonsdale St MELBOURNE 67 9834 • 260  
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DSE/A053/LM



# Metal Film technology at carbon prices

## SFR Standard Film Resistors

### PHILIPS

At last. A range of metal film resistors with improved performance over carbon film types, at the low prices you'd expect to pay for carbon film resistors!

We're talking about Philips' new SFR25 range of 5% tolerance — 1/4W metal film resistors. With a quality and price made possible only by advancements in metal film technology and the massive scale of our automated manufacture.

SFR25's feature a 'clean lead' finish and are constructed to the same high standard as the Company's 'MR' series. Resistance coverage from  $1\Omega$  to  $1M\Omega$  (E24 values) with a tolerance of  $\pm 5\%$  is assured. Maximum power dissipation is 0.33W at  $70^\circ\text{C}$  ambient.

They have a noise figure of less than  $0.1\mu\text{V/V}$  (a tenth of the carbon film noise figure) and a temperature coefficient of less than  $250\text{ppm}/^\circ\text{C}$ . Even more important, neither parameter shows degradation with increasing ohmic value. These improvements stem primarily from the homogeneity and stability of the resistive deposition.

So there you have it. Another quality product, ahead of its time, from Philips. For further information phone:

**Philips Electronic Components and Materials,**  
P.O. Box 50, Lane Cove, 2066. Phone: Sydney 427 0888,  
**Melbourne 544 2444, Adelaide 45 0211, Brisbane 44 0191 Perth 277 4199.**



**Electronic  
Components  
and Materials**

# Shoparound

THIS PAGE is to assist readers in the continual search for components, kits and printed circuit boards for ETI projects. If you are looking for a particular component or project — check with our advertisers if it is not mentioned here.

## ETI-660 Computer

No doubt most readers have found that this project is widely stocked as a kit. For those using components on hand and shopping around for other parts to save money, pc boards are readily available — if you're not making your own. If you are making your own then artwork is available directly from us. Send a large (at least 300 x 250 mm) stamped, self-addressed envelope to ETI-660 PCB, ETI Magazine, 15 Boundary St, Rushcutters Bay NSW 2011. If you don't want to make your own, pc boards may be individually available from Rod Irving Electronics and Ellistronics in Melbourne, Radio Despatch Service and RCS Radio in Sydney and Jemal in Perth.

The 400 ns delay line comes from a Pye TV, model no. T29, and its part no. is 157-507-38. You may be able to obtain it through Philips Service centres, or some kit and component suppliers may sell it separately. Other 400 ns delay lines may be pressed into service — the only requirement is the 400 ns delay.

To get an EPROM programmed ('blown' is the jargon) you'll have to seek out a computer hardware firm that runs an EPROM-programming service and see if they can do the job for you. Again, some of the kit suppliers may be able to supply you with a ready-programmed EPROM for the project. The program listing is given in the construction article.

The 8 Vac/1 A plugpack we used came from Ferguson Transformers and is their model no. PPB8/1000. You can use a conventional transformer if you wish, as suggested in the construction article, but it will have to be mounted out of harm's way along with properly organised and terminated mains wiring.

Housing the project is not a problem and you can suit yourself — anything from screwing the pc board and modulator to a suitably sized piece of wood to putting it all inside a nice plastic or metal case — or you can make up a case to our plans. Only simple tools are necessary if you follow the latter course.

To satisfy enthusiastic Victorian customers, Dick Smith Electronics has opened another store, his fourth in Melbourne. Situated at 260 Sydney Road, Coburg, it boasts "everything you would want in electronics". Dick urges you to call in and meet the manager, Paul Gursanscay, and take advantage of "the many bargains and direct import prices". Go and bash Paul's ear — tell him to stock more ETI kits!

Case assemblies made to our design will be available from several suppliers, we understand.

The ICs are generally widely available, or should be by the time this is published. The 1802 and 1864 chips are made by RCA and distributed in Australia by AWA Microelectronics Division, 348 Victoria Rd, Rydalmere NSW 2116. (02)638-9022.

## ETI-158 Low Ohms Meter

There is little specialised about this project so readers should have no difficulty with parts availability. Even 1% and 2% tolerance resistors are common components these days.

For terminals we used two two-way quick-connect speaker terminals. These are convenient as they have one red and one black terminal each so that polarity is automatically determined. We obtained ours from Dick Smith and they're listed as catalogue no. p.1764. However, numerous similar types are widely available.

The spring-loaded toggle switch is not a common item but can be found with a little digging in stores that carry generally a wide range of components. We bought ours at Radio Despatch Service in Sydney, but as it is a C&K type supplier who carry C&K switches may have it in stock or be able to obtain it.

A variety of common meters may be used and we have provided artwork for scales for three common types — the Minipa MU-45, the SEW ST65 and the University TD66. We understand University Graham Instruments will be making meters available with our scale design included. Check with your supplier.

Scotchcal front panels and meter scales should be available from the usual suppliers — All Electronic Components and Rod Irving Electronics in Melbourne and Radio Despatch



Service in Sydney. Jemal in Perth may have supplies, too.

We used a collet knob for the range switch, but any suitably sized pointer knob will suit. Collet knobs from Associated Controls and C&K are now quite readily available from numerous outlets, so you should have little difficulty getting a knob to suit.

While multturn horizontal mount trim pots are reasonably common, not every supplier stocks them. Check your favourite supplier first.

The Jiffy box we used came from Altronics in Perth and it features board guides that allow the board to 'snap in' position. It was a type no. H0102 and measures 196 x 113 x 60 mm. As Jiffy boxes are legion, we don't think you'll have much trouble finding one to house your project.

Printed circuit boards should be readily available. In Perth, Jemal; in Melbourne, Rod Irving Electronics, Ellistronics and All Electronic Components; in Sydney, Radio Despatch Service and RCS Radio.

## ETI-596 Noise Gen.

If you have any problems with this, then you *really* have problems! All components are widely stocked and the pc board should be obtainable from the previously mentioned suppliers.

## Intersil ICs

Over the past year or so we have used some of the unique chips from the Intersil range — such as the 7106 dpm chip and LAD204 LCD display featured in the ETI-572 pH Meter published last December. R&D Electronics, the sole Australian representatives for Intersil, have appointed All Electronic Components of 118 Lonsdale St, Melbourne, as a distributor for their products.

So if you are interested in Intersil ICs, see A.E.C.!

# COMMUNICATIONS

## NSW Police call on WICEN again

Following an unsuccessful search and rescue attempt to find a light aircraft that disappeared on 9 August (see this column, October issue), NSW Police again called on WICEN to assist in a search for the aircraft late in September.

**The Cessna aircraft, VH-MDX, is believed to have gone down in the Barrington Tops area north of Newcastle, regarded as the most heavily forested, rugged and inaccessible part of NSW.**

Although the search failed to find the aircraft, it proved that specialised volunteer groups can work together and with the statutory authorities in a major operation. 452 men and women from the Police, State Emergency Services, Army Reserve, Forestry Commission, Hunter District Water Board, National Parks and Wildlife Service, Hunter Valley 4x4 Club and many Volunteer Rescue Association squads were involved.

The Wireless Institute Civil Emergency Network was activated by the NSW Police. Amateurs came from Hunter Region, Central Coast Region and Taree WICEN to provide radio links between the Police Control Centre at Dungog and various groups of searchers. Amateurs manned field stations deep in the Barrington Tops for up to 52 hours, literally bedding down next to their radios. Operators had to provide and establish portable stations on 146.0 MHz, 146.9 MHz (repeater 6900), 7.05 MHz, 3.6 MHz and 439.0 MHz. Radios on the VRA rescue frequencies were provided by the squad involved. WICEN also provided a TV crew to film SES and

WICEN personnel in the operation, for training purposes.

After seeing the rugged area they were required to search, the Police Air Wing Chief Pilot requested a portable on the WICEN frequency in case they had to make a forced landing. This was provided but fortunately was not needed.

When one seemingly undeliverable message was offered to the other services involved, a comment was heard: "Give it to WICEN, they can do anything"; the message was delivered.

Amateurs operating in the search area were VK2s — BVO, YUP/PEP, KAL, BJC, KBN, DCW, NZW, AVO, DVL, GL, BSC, ZED/PED, BUL, ZRT, BVT, BVI, BVQ, YCB, BMK, YFJ/NLO, VWD, BRF, ZVF, NUM, AOH, BMM, KCS and DKP.

VK2BOT and VK2BGF operated in Taree, VK2TS and VK2BUQ manned stations in Gosford, and VK2NL, DHG, NFF, NWA, AGS, DI and DEX were operating in Sydney.

A special thanks must go to Ray Wells, VK2BVO, Central Coast Region WICEN co-ordinator, Max Francis, VK2BVO, North Coast Region WICEN co-ordinator, and Charles Withers, VK2BVI, Taree local WICEN co-ordinator, for their support in this large operation.

**Kim Piper, VK2DKP  
Hunter Region WICEN  
Co-ordinator**



Roma Piper, VK2NZW, hands a 2 m transceiver to Police Chief Pilot Peter Leslie, who requested it for emergency communications in case of a forced landing. Photo by Mike Richter, VK2BMM.



### 27 MHz marine SSB transceiver

**Recent revision by the Department of Communications of the 27 MHz On-shore Boating Radio Communication Service now provides for the use of SSB transmission on 27 MHz.**

Dick Smith Electronics now have available a fully approved AM/SSB transceiver which meets the new Government requirements and costs only \$249.

The Stalker IX transceiver, Cat. No. D 1715, comes fitted with the maximum number of allocated channels and provides for further expansion to 12 marine frequencies. In addition, the set complies with the boating industry list of

standard features include a public address facility, fully variable microphone gain, RF gain control for overload protection, and receiver clarifier control. The unit is supplied with mounting bracket, power cord, microphone bracket and comprehensive instruction booklet.

To page 97

# AMATEUR RADIO



## HUGE SCOOP PURCHASE!



### SAVE ON THE 'NO FRILLS' FT107

YOU REAP  
THE BENEFIT

ONLY  
**\$850<sup>00</sup>**  
WHY PAY  
**\$1278?**

Here's your chance to up-date to one of the best transceivers in the world, at a true bargain price!

Dick Smith has just made a scoop purchase of the entire manufacturer's stock of the famous FT107M transceivers - at an incredible discount.

They have all the outstanding features that have made the FT107M Australia's most popular top-line transceiver, and include all of the current legal amateur bands. (They don't have the new WARC bands included - but why pay hundreds of dollars more for bands we may NEVER get to use?)

Hurry: stocks are strictly limited - and as we bought the entire manufacturer's stock, this offer can NEVER BE REPEATED!

D-2863

#### SPECIFICATIONS:

**Frequency coverage:** 160, 80, 40, 20, 10  
**Modes of operation:** LSB, USB, CW, AM, FSK

**Input power:** 240W DC (SSB), 80W DC (AM, FSK)

**Sensitivity:** 0.25uV for 10dB S/N (SSB/CW/FSK), 1uV (AM)

**Selectivity:** 2.4kHz (-6dB), 4kHz (-60dB) SSB, cont. variable from 300 to 2400Hz

**Carrier Suppression:** better than 40dB

**Spurious radiation:** better than 50dB below rated output

**Power requirements:** 240V & 13.5V supplies built-in

### THE MANY BENEFITS OF BUYING YAESU FROM

## DICK SMITH

- We sell more Yaesu than anyone else: so we have the best stocks, at the best prices (tell us if we're wrong!)
- We have the largest service centre: if something does go wrong with your Yaesu, we can fix it fastest!
- We honour Yaesu's 12 month guarantee - beware of others who may offer you only a 90 day warranty.
- Dick Smith Electronics have over 22 stores throughout Australia - plus over 200 approved re-sellers. You're never far from friendly help.
- We know amateur radio - we have 32 licensed amateur radio operators on the staff including Dick Smith & Ike Bain the Managing Director.

**AND WE GIVE YOU A FULL 12 MONTH GUARANTEE!!**

**FINANCE TO APPROVED PERSONAL CUSTOMERS OR USE YOUR BANKCARD**

CHECK  
THESE  
OTHER  
GREAT  
DEALS

**Most popular communications receiver in the world!**



### 20,000 KM RANGE YAESU FRG-7

More Yaesu FRG-7's are in use throughout the world than any other communications receiver. Check these outstanding features:

- Features the famous 'Wadley Loop' for rock-solid stability & minimal drift!
- Triple conversion superheterodyne circuit for extremely high sensitivity with excellent selectivity (better than 0.7uV, -6dB @ 3kHz & -50dB @ 7kHz).
- Operates from 100/120/220/240V AC or 13.5V DC.
- Weighs only 2kg, size 34 X 15 X 29cm.
- 2IC, 22 transistor & 16 diode circuitry.

D-2850

~~WAS \$385 LAST YEAR!~~  
ONLY \$359<sup>00</sup>  
SAVE \$40

### DICK SMITH Electronics

Australia's largest supplier and Yaesu factory approved distributor & service centre.

**NEW! NEW! NEW!**

### VHF Handy FM Transceiver **FT-208R**

The FT-208R transceiver brings a new flexibility to today's active 2M operator. An easy to read LCD display is coupled with a 4-bit microprocessor, bringing 10 memories & a scanning function. Only with Yaesu can you get these features at such an economical price. Check it out NOW!

INC. CHARGER

Cat. D-2889

ONLY  
**\$368**

### Yaesu's brilliant FRG 7700/SW



There's not much we need to say about this outstanding receiver: let the features speak for themselves

- 2MHz - 30MHz continuous!
- All mode - including FM (great with converters)
- Digital frequency readout, with digital clock.
- Superbly easy to operate: set pre-selector, then tune!
- Timer for tuning receiver on/off, plus control of external equipment eg. (tape recorder)

D-2841

**EXCLUSIVE TO DICK SMITH**  
NEW  
ONLY \$499<sup>00</sup>

### OPTIONAL MEMORY UNIT

Gives you single button recall of any of 12 chosen frequencies. Great for monitoring, 'skeds', etc. Simple connection, instructions inc.

D-2842

The FRG 7700 is an ultra compact antenna tuner. Designed to operate from 150kHz - 30MHz, it will provide the proper impedance for the receiver, rejecting unwanted signals. Also has a built-in 60dB max. attenuator plus a two-section lowpass filter aid for rejection of strong signals above 2MHz.

D-2843

### FRV 7700 VHF 2-6 metre converter

Increase the listening range of your FRG-7700 with this high performance frequency converter. You'll be able to listen to all the amateur activity 'up top', plus aircraft & land mobile stations, etc. Makes great VHF listening!

ONLY  
**\$124<sup>50</sup>**

D-2844

### MOBILE CHARGER

D-2894

The Yaesu PA-2 is a mobile charger, come pwr supply. Suited for the FT207R & FT208R. Uses the power from your 12V battery when mobile. Also recharges nicads in your battery pack.

ONLY \$29<sup>95</sup>

### TOP OF THE RANGE SSB/HF transceivers



### FANTASTIC FT-107 DMS

This has to be Yaesu's finest transceiver. A masterpiece of solid state engineering - you only have to take the cover off to see the thought & care that has gone into its design. Full band coverage, of course - in all modes (FSK included). A massive 240W PEP input, with features like RF speech processor, variable bandwidth, superb noise blower. PLUS 12 channel memory. The FT-107 is everything you want from a transceiver and a little bit more

D-2871  
**ONLY \$1328**

### Antenna Coupler FC 107

D-2873  
Problems with antenna mis-match on your FT-107? Not with this superb coupler. Designed to match the 107 styling, but just at home with any transceiver. Huge meters for power output and SWR. Superb quality!

ONLY \$205

### FT-902D our most popular HF transceiver



D-2853

The FT-902D has just about everything you've ever wanted in a transceiver. All modes (yes, even FM - great with converters), & all bands from 160 to 10M (including WARC). You get digital readout, RF speech processor, rejection tuning, 180W PEP input, etc. etc. . . So come in to one of our stores & check it out & ask for your free brochure.

ONLY \$1195

### Antenna Coupler FC 902

D-2855  
This coupler can feed anything from a random length of wire to a beam. Match the load perfectly so you can deliver more power up there where it's wanted! Suits all bands, has built-in SWR/pwr meter as well. 50 or 75 ohm system, 500W rating.

ONLY \$265

D-2855

## Mobile or base



D-2869

### FT-707

Yaesu has used the 'state of the art' technology & put it into such a tiny package. Yes, it's the brilliant FT-707. This little wonder contains all the outstanding features that most big rigs lack. It's a full power, all HF band (inc. WARC) multi mode transceiver. You get digital readout, LED S/power meter, push button operation, all the things the amateur needs for safe reliable operation. You've waited a long time for a rig like this, so take the splurge now, it's well worth the money.

**ONLY \$795**



### Antenna Coupler

Get the most from your FT-707, use the Yaesu FC-707 antenna coupler & ensure your transceiver always delivers the power it should. Has all the features you need: pwr/SWR meter, in-built dummy load, all band coverage (including WARC), less than 0.5dB insertion loss.

D-2875

**ONLY**

**\$149<sup>b0</sup>**

### Base operation?

Just add the FP-707 mains supply & you're away. You get fully regulated 13.5V at 20A. Has plug-in connections so you can't cause problems, plus you get an extra speaker - for greater clarity.

D-2895

**ONLY**

**\$175**

### Digital VFO



Long'n'slim - intended to sit under the 707. 12 memories, up/down scanning, in 10Hz steps & receiver offset tuning. Power by FT-707. D-2896

**ONLY**

**\$299<sup>b0</sup>**

### Mobile bracket

Don't let your valuable 707 jump all around the car. Fit it in this superb mounting bracket for safety & security. Also holds the digital VFO. A must for the serious mobile operator. D-2897

**ONLY**

**\$36**

**DICK SMITH  
WILL BEAT  
ANY GENUINE  
ADVERTISED  
PRICE ON  
YEASU  
EQUIPMENT.**

## Economy HF/SSB The FT 101Z



D-2862

Here is one of the finest transceivers in the 101 family: the FT-101Z. This brilliant performer is packed with a host of features, that the more expensive radios lack. So why pay more when you can get features like RF speech processor, variable IF bandwidth, all current HF bands (inc. WARC) 180W input (SSB/CW) & AM/CW/SSB operation & many other features to numerous to mention. So do yourself a favour and check it out NOW at a store near you!

To sum it up in one word, superb!

**ONLY \$795**

### FT 101ZD

**STOCK  
LIMITED**

Remember the famous FT-101B? And the 101E? Here is one of the most popular of the 101 series. It has all the features of the famous 101Z but includes digital frequency readout. Stocks are limited so ring the nearest store & check if they have stock left.

D-2859

**ONLY \$910<sup>b0</sup>**

## NEW! FT 101Z FM

Now you can have the features of the renowned FT-101ZD with the benefit of FM. Get crystal clear reception & trouble free interference. It makes a great combination!

**\$885**  
D-2872

### DC-DC Inverter

Want to go mobile? Add this superb DC/DC inverter to your car battery. (13.5V nominal). Don't tie yourself to your shack - get out to where the DX is great!

D-2864

**ONLY**

**\$177**

### FL-2100Z 1.2kW Linear Amp.

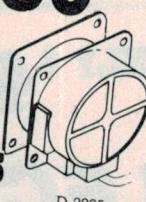
If you want a linear amp. built like a 'power house', that gives you a clean, strong signal, try the new WARC FL-2100Z. Australian amateurs can be assured that at our maximum legal limit of 400W PEP the FL-2100Z is just 'coasting' - resulting in years of extra life. It features twin cooling fans for reliable operation & gives plate voltage, VSWR & DC readings from its two large meters. Suits virtually all amateur transceivers on the market.

**ONLY \$580**  
D-2548

### Yaesu Fan

Give your FT-101Z a break by installing a cooling fan. Comes with all the fittings, 110V operated (runs from a tap on the transformer)

**ONLY \$29.95**



D-2865

Yaesu's top 2 metre  
FT 480R has FM/CW & SSB



Yaesu call this their 'total performance VHF computerised transceiver.' And total performance it is! As the top-of-the-line Yaesu 2M family you'd expect a lot. You get FM, SSB CW over the full 2M band, with two VFO's, four memory channels, scanning, digital readout, hi/lo power switch & much, much, more.

**ONLY  
\$525**

D-2887

## PLL scanning 2 metre FT 227RB



**ONLY  
\$319**

D-2891

One of our most popular Yaesu transceivers we have ever had the pleasure to operate the incredible FT-227R. The PLL scanner will take you anywhere within the 2M band instantly - just press the scan button on the microphone. Has four memory channels, power output of 50W, & the receiver has better than 0.3uV sensitivity (10dB S/N). It operates on 13.5V DC, with protection against reverse polarity & high antenna SWR. For value-for-money, it's hard to go past the FT-227RB.

## SPECIAL OFFER

### FREE

If you purchase a D-4100 base with resonator, we will give a **FREE** 2M stub (D-4102) worth \$11.25 at no extra charge.

**GUTTER MOUNT**  
Cat. D-4100

**2M STUB**

When you buy the gutter mount base & 2M stub, you're on the air on 2M immediately. As you want the HF bands, simply buy that band resonator/antenna whip & screw it into the 2M stub. You only have to buy the whips for the band you want. Go mobile with Yaesu.

**RESONATORS: Cat. D-4104 - D-4118**

RSE - M - 2 GUTTER MOUNT Cat. D-4100	<b>\$24.95</b>	RSL - 7 40M ANTENNA Cat. D-4112	<b>\$25.50</b>
RSE - 2A 2M STUB Cat. D-4102	<b>\$11.25</b>	RSL - 14 20M ANTENNA Cat. D-4114	<b>\$25.50</b>
RSL - 145 6M/2M ANTENNA Cat. D-4104	<b>\$27.50</b>	RSL - 21 15M ANTENNA Cat. D-4116	<b>\$25.50</b>
RSL - 3.5 80M ANTENNA Cat. D-4110	<b>\$25.50</b>	RSL - 28 10M ANTENNA Cat. D-4118	<b>\$25.50</b>

## NOVICE POWER HF/SSB

There aren't many transceivers available in Australia which are particularly suited to novices - but won't disgrace themselves either. The Yaesu FT-7B suits the novice as well as the full call amateur. Gives you all the current HF bands with power output up to 50W. You also have the option of AM, CW or SSB with the choice of VFO or a crystal locked channel. The FT-7B is ready when you are, hook up your power & antenna & away you go!

**NOW  
ONLY**

**\$549**



D-2868

# NEW! NEW 2 METRE PORTABLE FT 290R



ALL MODE  
FM/SSB/CW

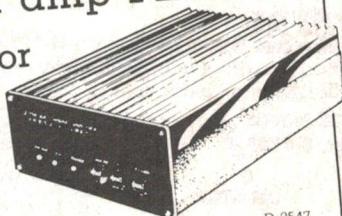
The FT-290R is a highly sophisticated compact multi-mode transceiver for the 2M amateur band. Featuring PLL synthesis in 100Hz, 1KHz, 5KHz, or 10KHz steps. The FT-290R utilizes a Liquid Crystal Display for digital readout for the operating frequency, 10 memories, scanning of the band or memory channels, two VFOs, & receiver offset tuning makes the FT-290R a significant breakthrough in technology.

**ONLY \$395<sup>00</sup>**

# NEW! NEW

VHF Power boosted  
linear amp FL-2050

Ideal for  
all 2M  
rigs



D-2547

Add this to your hand held for real mobile power. Also suitable for SSB, CW, AM etc. Operates from 13.6V DC up to 15W input for maximum power. Includes 12dB receiver pre-amp, with automatic transmit receive control.

**ONLY \$239<sup>00</sup>**

# DICK SMITH ELECTRONICS

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# COMMUNICATIONS

## November 2 — CB-Day for Britain

The new CB radio facility will start in the UK on November 2 1981. Licences will be available over the counter at post offices for a fee of STG£10 from this date, and one licence will cover the use of up to three transmitter-receiver units using frequency modulation in the 27 MHz or 934 MHz bands.

The licence will cover anyone who lives at the licensee's home, any employees of the licensee and anybody who hires the equipment from the licensee for not more than 28 days. Each additional payment of £10 will cover the use of up to three more units; there is no maximum on the number of units which may be used.

Equipment sold for this new legal service must carry on the front panel a circle containing the legend CB 27/81 or CB 934/81 according to the band for which it is to be used. The existing 27 MHz AM units at present being used illegally will remain illegal unless they are converted to meet the specifications of the new service.

It is expected that initially 27 MHz will be used by the vast majority of CB operators because of equipment availability. It is for speech only and will provide 40 channels between 27.6 and 28 MHz with a transmitter power of 4 W. Maximum range is expected to be some ten to twelve miles, depending on the terrain.

There will be a ban on advertising or soliciting goods or services and on offensive language, but otherwise CB messages will be unrestricted for speech. No music or Morse or other non-speech signals will be permitted. Business use will be permitted, so firms may use CB to communicate between offices or between their vans and their offices.

Two performance specifications

have been issued by the Home Office for 27 MHz and for 934 MHz equipment respectively and all equipment sold will have to carry a mark on the front panel showing that the equipment conforms to the requirements. In the case of 27 MHz, the antenna will be limited to a straight rod or wire up to 1.5 m long with a base-mounted loading coil to improve its efficiency.

The Home Office stresses that no AM equipment will be legalised in Britain and that there is no European standard at present, although the unification of European standards is regarded as a long-term objective.

The British Home Office makes it clear that CB radio is intended to be a short-range system which is not intended for international communications. People who wish to communicate over long distances by radio should become licensed radio amateurs.

The Home Office has issued a brief voluntary code of practice to help CB users to operate so as to cause as little disturbance to others as possible and to operate safely (such as not transmitting when they are at a petrol filling station and not transmitting when the antenna is within about 10 cm of their face).

Britain has waited a long time for CB radio and many people have suffered interference from the illegal use of AM. Users await the future with keen anticipation.

Brian Dance

## New UHF CB portable from Philips

Philips-TMC, who pioneered the introduction of UHF to the Citizen Radio Service with their Australian-designed and manufactured FM320, have now released a portable unit to extend the usefulness of the service.

Called the FM323, it is housed in a lightweight aluminium die-cast case and weighs less than one kilogram when fitted with a rechargeable nickel-cadmium battery pack.

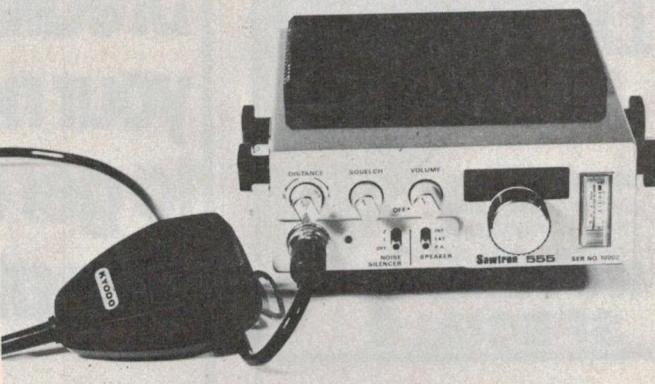
It is not difficult to visualise any number of useful applications on land, at sea or in the air. The unit is expected to prove very popular with a wide range of users: government, business and industry, rural, marine and leisure activities, from controlling road traffic and reporting to security and emergency situations.

Some of the interesting options

available with the FM323 are:

- A choice of readily replaceable dry batteries or rechargeable nickel-cadmium cells and a charger unit.
- Soft vinyl pouch or deluxe leather case.
- Tone signalling.

Philips claim the unit has an extremely sensitive receiver and quote a transmitter output of 300 milliwatts. Battery life of approximately 30 hours is expected with a nominal duty cycle of 180 minutes transmit and 180 minutes receiving spread over the battery life.



## New Sawtron marine

Imark has released the Sawtron Model 555 27 MHz marine transceiver, which they claim is not a modified CB radio.

The Sawtron 555 has been designed to operate on any dc voltage between 10 and 35 volts, as some vessels employ 12 Vdc systems while others have a 24 or 28 Vdc system.

Corrosion is often a problem in marine environments, so the Sawtron 555 case is made from anti-corrosion light alloy materials and uses stainless steel nuts and screws.

A splash-protected noise-cancelling microphone with a three-metre cord that remains flexible even down to -30°C is provided. Noise suppression circuitry is in-

cluded to facilitate communications in situations where ignition noise is prevalent. A 'break-in' terminal is also provided to allow use of another transceiver on board at the same time without causing interference to the Sawtron 555.

The transceiver has provision for 12 channels and has the six legal Australian channels fitted. An optional trumpet speaker and marine antenna are also available.

Further information is available from Imark Pty Ltd, 167 Roden St, West Melbourne Vic. (03)329-5433.

## Lone radio lady in Antarctic

After eight months in a cardboard hut on a remote plateau in Antarctica, the world's loneliest radio operator, Lady Virginia Fiennes, has talked her way into the history books.

Lady Virginia, wife of British explorer Sir Ranulph Fiennes, has been base station operator in Antarctica for her husband's Transglobe Expedition, currently triumphant after the fastest ever crossing of the frozen continent.

With only an array of expensive high technology radio equipment loaned by the Racal Electronics Group for company, she has spent lonely hours monitoring her

husband's progress over the white wasteland with his two fellow explorers, Londoners Charles Burton and Oliver Shepard. Her daily radio schedule included messages of encouragement to the trio as they battled their way 2600 miles over the South Pole to the Scott Antarctic base at McMurdo Sound.

—from Racal 'Grapevine', Spring 1981

## Club Call

The Brisbane Amateur Radio Club recently informed us of changes to its address, meeting place and net details. You can now contact the club at P.O. Box 300, Darra Qld. 4076, and meetings are held at the State Emergency Service 'C' Group Headquarters, Cnr. School and Ipswich Rds, Yeronga, Brisbane. Club nets are: Monday 7.30 pm EAT 28450; Monday 8.30 pm EAT 3570; and Wednesday 7.30 pm EAT Channel 51 — 146.660 MHz.

The South Coast Amateur Radio Club (callsign VK5ARC) meets on Thursday evenings at the Clubrooms, 12 Baden Tce, O'Sullivan Beach S.A. You can contact the club at P.O. Box 333, Morphett Vale S.A. 5162. Club net is each Tuesday evening at 8 pm on 3.595 MHz ± QRM. Visitors to the club and net are welcome.

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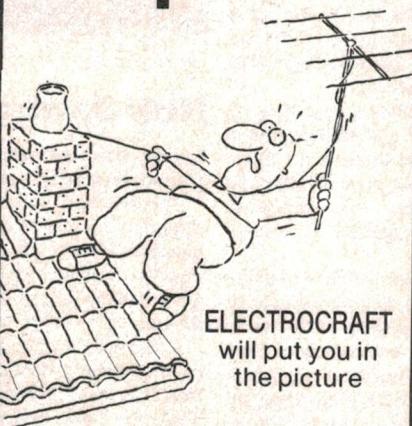
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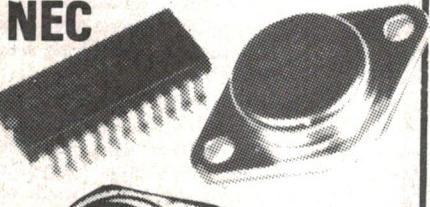
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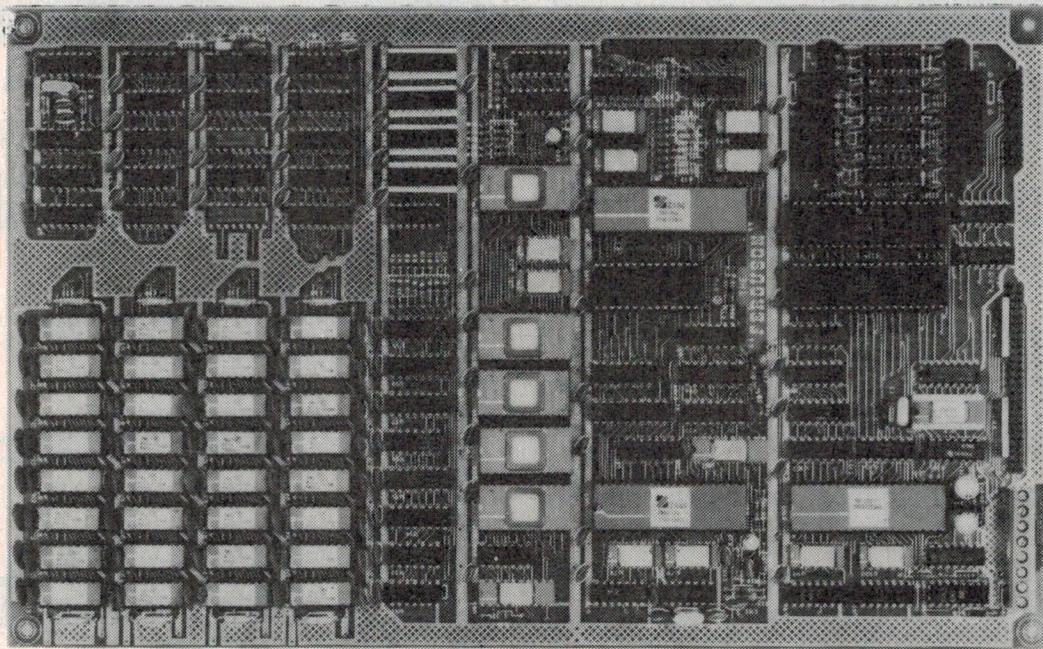
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A book to suit the dyed-in-the-wool experimenter. Though primarily concerned with VMOS power FETs and their applications, power MOSFETs are dealt with too in a chapter on audio circuits. A number of varied and interesting projects is covered under the headings: Audio Circuits; Sound Generator Circuits; DC Control Circuits and Signal Control Circuits. Learn while you build.

**BP83** \$7.20

## DIGITAL IC PROJECTS

Companion to No. 225 Practical Introduction to Digital ICs and BP61 Beginners' Guide to Digital Electronics. The projects included in this book range from simple to more advanced projects — some board layouts and wiring diagrams are included. The more ambitious projects have been designed to be built and tested section by section to help the constructor avoid or correct any faults that may occur.

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## INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE

Companion to BP1 and BP14 equivalents books, but contains a huge amount of information on modern transistors produced by over 100 manufacturers. Wherever possible, equivalents are subdivided into European, American and Japanese types. Also shown are the material type, polarity, manufacturer and indication of use or application.

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# COMPUTING TODAY

## 'Shop by computer' with Dick Smith

While everyone else in the world is talking about it — Dick Smith has done it!

**He has introduced Australia's first "Shop by Computer" System — a system where you use your personal computer through your telephone to shop from your home or business, anywhere in the world, directly onto the Dick Smith Computer.**

Dick Smith is so excited about this new system that he foresees the day when most of his 45 000 mail order customers will use this system. With \$4 million turnover from these customers, Dick wants to make it as easy as possible for them.

Until now, ordering electronic equipment by mail order has cost the consumer a lot of time and money. The order, by mail, can take up to five days (at best!) to reach its destination. By using the 'Shop by Computer' System, the customers can place an order through their own personal computer, and at the touch of a key the order is received

at Dick Smith Electronics in less than a minute.

The Dick Smith Ordering System is said to be simple to use and anyone with the right equipment can take advantage of it. All you need is a Dick Smith System 80 or a Tandy TRS-80 computer, an expansion unit with an RS-232C port, a 5½" disk drive and an acoustic coupling modem. As an introductory offer Dick Smith is making the simple program available at cost price (about \$5). Over Australia there are 12 000 owners of Dick Smith and Tandy computers, and all of these can use this system.

Once you type your order into your computer, you phone Dick Smith's number and your order is transferred directly to the Dick Smith Computer. The computer acknowledges receipt of the order and also lets you know the latest specials that Dick Smith Electronics has to offer. Your order is also given preferential despatch treatment and



would normally be on its way within four hours of its being received. It is also automatically billed via a nominated credit card account.

Dick Smith says, "I predict now that we have the System that thousands of our customers will buy using it."

### Fountain of knowledge

**The Source is with us! That famous Californian data bank, 'The Source', now has a counterpart right here. Called the Australian Source, it is a division of Tergo Quen Pty Ltd, headed up by well-known computer industry identity, Gary Alpert.**

"The launching of the Australian Source microcomputer network in Australia is probably the most singularly important event yet to take place in the microcomputer industry in this country," he said when announcing the launch.

"For the first time, the world of huge data banks and massive computer power previously only available to large corporations and government departments can now be put into any office or any home for less than the cost of a few packets of cigarettes a day.

"Thus this is really the beginning of the era of the home computer, as now virtually any small businessman or any student can have on his desk for an extremely small cost a

system that has the level of storage power and access to data banks that only a few years ago government departments and large private users were paying millions of dollars for."

The Australian Source is a computer information utility which can be accessed through any number of 'approved' personal microcomputers. Through this system, microcomputer owners will be able to:

- have access to a number of information sources, which will include the news, financial reports and sports;
- communicate nationwide with other Australian Source users — virtually an electronic mail system;
- have access to a myriad of

computer programs that include entertainment, educational aids, programming and diagnostic tools and financial applications;

- have the capability to make use of the mainframe's huge storage capacity, to use its large programs or store your own programs in the system;
- take advantage of the 'shopping by computer' system to get the best price of many popular consumer items.

To join the Australian Source you need to have an 'approved' microcomputer system. At present the following systems may be used: Apple, Atari, Casio, Commodore, System 80, TRS-80 and numerous S100 systems (you need a disk-based system with CP/M). Mr Alpert expects the range of suitable systems to be expanded rapidly.

There is a one-time joining fee

and a small hourly charge for usage. The joining fee is \$100, but 'charter' members joining now get a discount and the fee is only about \$60, according to Gary Alpert. The hourly rate works out at about \$10 per day for use during business hours, dropping to around \$4 per day where usage is mainly during the evenings.

Initially, for users outside Melbourne, where the central computer is located, users will have to make an STD phone call to access the Australian Source, but by February or March next year Gary Alpert expects that users in the capital city metropolitan areas will only have to make a local call.

For more information, contact the Australian Source, 364 Latrobe St, Melbourne Vic 3000. (03) 329-7998.



# APPLIED TECHNOLOGY -

## The Starter Pack

Do you want to build a computer which won't end up limiting your needs and interest? Are you tired of 'packaged' systems which are never exactly what you want? Do you want to get into computing for as little as \$349 and have a machine which can run some of the most powerful software available? Do you want a full S100 expandable machine? Then you need to know about Applied Technology's Z80/S100 computer cards and systems.

As Australia's largest manufacturer and designer of Z80/S100 cards we have the know-how to offer a range of systems tailored to suit you. You can start with low cost kits and modules (all backed with the finest technical support), and build up to a full disk based system running CP/M and the world's finest software.

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The ultra-powerful DGZ0 S100 CPU board (kit form). This board offers features such as built in printer interfaces, an

extremely powerful monitor in ROM, an 8-bit input port, two programmable I/O ports, a real time clock (yes you can have the computer perform time related tasks, as many of our industrial customers are doing now).

The MW640 VDU Board. This is a professional VDU board offering upper and lower case (and a screen that doesn't flicker every time you key something in). It produces 16 lines of 64 characters. Chunky graphics are also available.

We can't do justice here to the power and flexibility of these cards. We believe they will give you the finest takeoff point available in personal computing today. Learning to operate them, with AT's technical and software backup will give you more computer understanding than on any other Micro.

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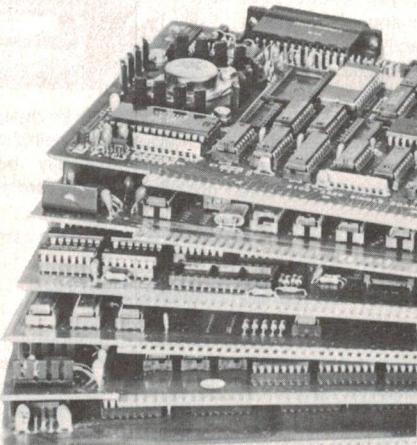
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The MICROWORLD DIGITALKER is based on a speech processing unit and encoded ROMs from National Semiconductor. Although an S100 device, the Digitalker is port oriented and can be readily adapted to interface with virtually any microprocessor such as INSTRUCTOR 80, TRS-80, SORCERER or SYSTEM 80. Comes complete with technical applications notes. It has 143 addressable expressions, giving it a huge vocabulary.

**\$149**

## WOULD YOU LIKE TO KNOW MORE?

Then send for our catalogue of computer products. It gives full technical details and introduces you to our wide range of S100 products, software & peripherals. Find out about our Newsletter - keeps you informed about new products & developments in the MicroWorld range.

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## SOFTWARE

### NEW

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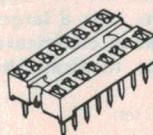
Because we are a major Australian manufacturer of S100 computer products, we buy huge quantities of digital and computer related ICs and hardware. You benefit from our technical knowledge and buying power. You can now buy the same components that we use in our own manufacturing (so they have to be good) at prices which make most 'computer suppliers' look very expensive. The items on this page show only a few of our lines, which now total over 5,000!! We have compiled a price list. Send or phone for it today!

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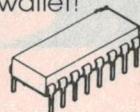
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# Print-out



## Painless computerisation — how it's done

When the management services officers of Western Australia's Department of Education decided to investigate word processing and its implementation in their department, they certainly did their homework well.

They looked at the short term word processing needs of the Department — to cope only with such things as the preparation of its budget — but, with a staff of 160 typists, finally decided on a more integrated approach.

By various surveys, interviews and workload assessments in seven separate geographical and functional areas, they assessed whether word processing was economical, viable and suitable for the Department's needs, both short and long term. Having established that word processing could be installed successfully, they put the system required out to tender, specifying shared logic, storage amounts, etc, and the ability to expand later.

One of the first problems encountered by the officers was understanding the jargon spoken by the computer personnel of the companies which responded to the tender. As one of them put it, "We needed to learn their language so we could fully understand what they were offering. We couldn't afford to be left out in the cold because of our own lack of knowledge."

The management services officers looked at various installations in different applications around Australia, paying particular attention to installations which did not work well in order to learn from

other people's mistakes rather than their own! They finally settled on three Wordplex/2 and one Wordplex/4 word processors and four screens from Sigma Data, the assurances given by the company regarding support facilities being one of the deciding factors. Sigma Data place a great deal of emphasis on support, employing a large number of engineers and MSRs to look after customers' needs.

The management services officers did not forget the last vital link — the operators of the carefully selected equipment. "One thing we have learnt is that it is far more efficient and productive to use the equipment to its fullest capacity. Therefore, to encourage a positive attitude to word processing by all our typists, we felt education was vital. As a result, we organised a series of talks at each location, an audio-visual display, seminars for authors and other aids as an introduction to the whole concept."

With all the effort and dedication that has gone into installing a computer system, the WA Department of Education deserves to have one of the most efficient computer installations in the country!

Sigma Data Corporation may be contacted at its Head Office, 157 Walker St, North Sydney NSW 2060. (02)922-3100.

## Sorcerer notes

A.P.F. Fry, who writes our Sorcerer Apprentice column every month, dropped us a line recently to tell us of a modification to a program he previously sent us.

While experimenting with the routine published in the February '81 issue to test whether or not your printer is connected, he found that if the program containing this routine, or a previously run program, has used the keyboard scanning routine published in ETI December 1980, the program will drop back to the monitor and print:

ERROR — INVALID COMMAND

This can be corrected with the following routine:

```
10 POKE 318,219:POKE 320,201
20 PR=INP(255)
30 IFPR=255THENPRINT"THERE
IS NO PRINTER CONNECTED"
:END
40 PRINT"THERE IS A PRINTER
CONNECTED"
Line 10 restores locations 318 and
320 to their initial power-on con-
dition and ensures the routine works
successfully.
```

Thanks for the information!

## New models from Casio

Casio's new pocket computer, the FX-702p, has a host of features too numerous to print here, plus a large program library of 73 programs covering mathematics, electrical engineering, mechanics, physics, chemistry, statistics, medicine, banking, navigation and games.

The FX-702p stores up to ten programs, has 55 keyboard functions, and is said to have a processing speed more than ten times as fast as other pocket computers — plus lots more! Programs and data may be recorded on an ordinary cassette by means of the FA2 adaptor, and the FP10 printer will also be available to interface with the pocket computer in the near future.

The FX-702p is priced at \$233.70 (\$259.95 including sales tax).

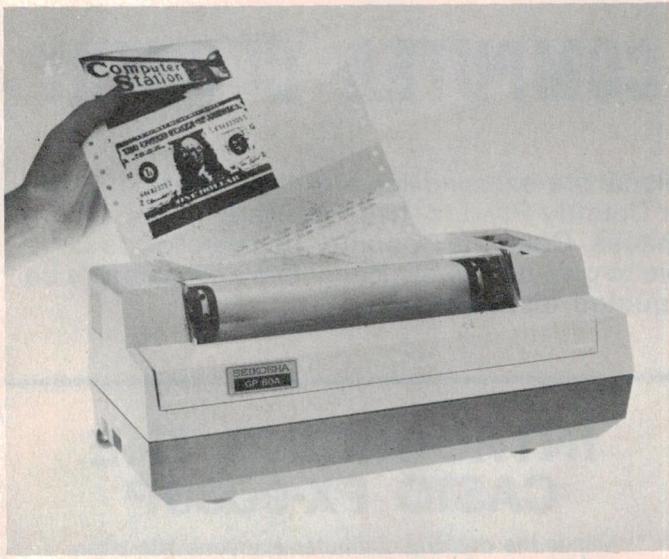
The new Casio FX-602p programmable pocket calculator has a dot matrix liquid crystal display which allows for upper and lower case characters, numbers and



symbols — 86 different characters in all. It is claimed to be extremely powerful, and has 50 mathematical and scientific functions on the keyboard. It can store up to ten programs on its continuous memory, and also interfaces with

the FA2 and FP10.

The FX-602p is priced at \$172.95 (\$189.95 including sales tax), and both it and the FX-702p are available from Calculator & Computer Distributors, 3 Rowley St, Seven Hills NSW 2147. (02)624-8400.



## New products at Electronic Concepts

**Electronic Concepts Pty Ltd now have available various new products in their distribution range.**

Micro Focus, the marketers of CIS COBOL and FORMS-2 (two professional software products) have released these products packaged especially for Apple II. The package consists of easy-to-use language extensions for CRT screen handling and a comprehensive interactive debug package. It is necessary to have the Z80-based Softcard (by Microsoft) installed.

Coinciding with the release of these products is the news that Telecom approval has been obtained for the connection of Apple II computers via their RS232C interface to any approved modem or modem/multiplexer. According to Electronic Concepts, the combination of an industry-standard COBOL and a communication facility is the last hurdle for Apple II to obtain acceptance in the COBOL-dominated world of EDP users.

Electronic Concepts also have available the Seikosha GP80, a small but heavy duty dot matrix

impact printer from Seiko which can be connected to the Apple II. The Seikosha GP80 features precise graphics resolution, single and double width characters, full ASCII, upper and lower case, self-test program, 80 cpi (12 cpi), low power consumption — and is small enough to fit in a shoe box!

Electronic Concepts have also become the sole distributor for the Infoscribe range of printers from California. There are four models of serial dot matrix printers featuring full 136 column printing at 10 cpi, with a wide variety of print options and fully program-controlled forms handling. The Model 500, with a recommended retail price of \$1840, is the basic model, followed by the Model 1000 at \$2100, the Model 1500 at \$2600 and the Model 2000 at \$3200, all plus sales tax if applicable.

For further information on all these products contact Electronic Concepts Pty Ltd, 55 Clarence St, Sydney NSW 2000. (02)29-3753.

## Natsemi price reductions

**To reflect recent pricing decreases in RAM devices, National Semiconductor is now offering a 25% to 35% average price reduction on its RAM memory expansion boards.**

In the 1 to 9 unit range, the RAM boards are priced as follows: BLC-8016 \$565; BLC-8016A \$655; BLC-8016B \$872; BLC-032 \$747; BLC-8032A \$837; BLC-8032B \$1113; BLC-048 \$1024; BLC-8048B \$1114; BLC-8084B \$1482; BLC-064 \$1210; BLC-8064A \$1300; BLC-8064B \$1730.

## Book Review

**Apple Machine Language**  
By Don Inman,  
**\$17.50**

**There has long been a need for a book such as this to introduce Apple users to the world of machine language programming. To date the only way to learn this subject was to obtain a self-teaching book on 6502, and while this was adequate for learning the instructions, most first-time users found it difficult to relate such information to their Apple monitor commands.**

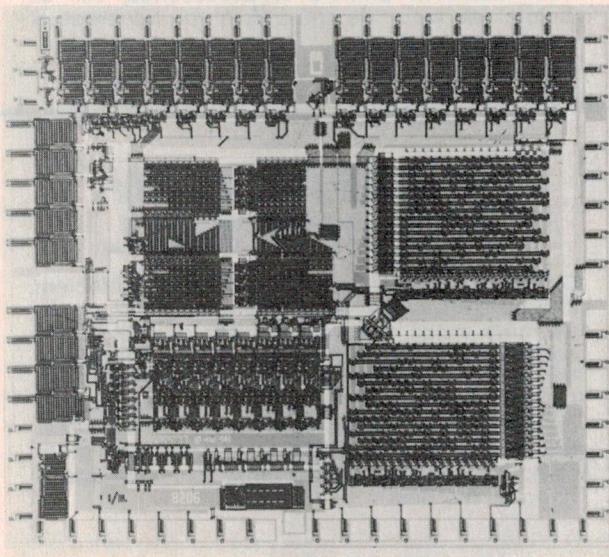
What was needed was a book which not only taught machine language programming to the person who had never even touched on the subject before, but also showed how to use this new programming method on the Apple.

This book seems to fill this gap very well indeed. It is easily understandable and does not assume any more than a modicum of knowledge in BASIC. Rather than attempting to teach machine programming by simply teaching the

necessary instructions, the book introduces each section as a series of exercises which the user can try on his or her system. These cover such topics as sound generation, graphics usage and displaying text.

I would definitely recommend this publication to anyone who wishes a painless and interesting introduction to using 6502 machine language on an Apple II.

**David Hanney**  
Computerland Sydney



## Error detection and correction

**A fast LSI device that detects and corrects errors from RAMs was announced recently by Intel Corporation.**

The 8206 error detection and

correction unit (EDCU) corrects single-bit errors and detects single, double and many multiple-bit errors as data is read from RAM. It is said to increase system reliability by a factor of at least 25. For example, in a typical microcomputer system with 128 kilobytes of RAM, the 8206 can extend that system's potential mean-time between failures (MTBF) from 1.4 years to 40.5

Production quantities of the 8206 should be available from September through Intel sales offices and licensed Intel distributors. The US price for the part is US\$62.50 each in quantities of 100.

For further information contact Intel Australia Pty Ltd, PO Box 571, North Sydney NSW 2060. (02)436-2744.

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# Printout

## IMS answer to new sales tax problems

Many users of computer programs to handle their invoicing and accounting procedures may be having nightmares about the computer chaos caused by the recent changes to sales tax.

IMS claims to have a software support plan (SSP) which would overcome all these problems. Costing \$500 per user per year, the plan covers the user for all legislative changes, such as in payroll or sales tax, as well as for later releases of all software in use. This in effect ensures that a customer's programs are up to date and will continue to be at the very latest level.

IMS Computer Systems say they have already released fixes to their programs to overcome the immediate sales tax problems, and have announced the methodology of implementing the changes when

it is necessary. The cost for this will be a maximum of \$200, but for customers participating in the SSP there is no additional cost.

The SSP also offers benefits such as a telephone query facility to the service desk, and discount training rates. Conversion programs are provided when substantial improvements require a change in the file structure, which avoids rekeying of data.

For more information contact IMS Computer Systems Pty Ltd, 582 St Kilda Rd, Melbourne Vic. 3004. (03)51-9156.

## Club Call

The Wollongong Computer Club is offering all interested people the opportunity to attend a course of instruction during which you will, with supervision, build your own computer — the ETI-660 (see ETI May, June and October 1981 and the article in this issue).

The offer is open to anyone in the community, and requires no previous knowledge of either computing or electronics; the course will start from the basic use of a soldering iron and take you through to the successful completion of your own colour computer.

The estimated cost of the course is \$110, which includes the cost of the computer and the supervision and instruction while building, plus instruction in the use of the computer.

Features of the ETI-660 include:

- Colour
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If you are interested, contact Paul Janson at P.O. Box 297, Dapto NSW 2530 (042)61-5451. Other computer groups in the Wollongong area are the **NSW 6800 Users' Group**, 27 Georgina Ave, Keiraville NSW 2500, and the **Australasia ZX80/MicroAce Users' Group**, 87 Murphys Ave, Keiraville NSW 2500.

The **Tamworth BASIC Users' Group** is currently seeking information on TRS-80 (Level 2 and 3), Sorcerer, Ohio and Sinclair microprocessors, and wishes to make contact with the respective user groups. They are a small group of interested people concerned with programming, operation and systems design, from hobbyists to small business users.

The **Newcastle Microcomputer Club** has been active for a few years, and meetings are held on the second and fourth Mondays of each month at 7 pm in the Physics building of the University of Newcastle, room G12. Interested people may contact the group via Gordon Johnson, Electron Microscope Unit, University of Newcastle, NSW 2303, or by phoning Gordon Johnson on (049)68-5405 during business hours.

A **Sorcerer Computer Users' Group** has been formed in the Australian Capital Territory, and will be closely allied to the Victorian-based **Sorcerer Computer Users of Australia**. Interested persons should contact Mr. G.T. Dick, 31 Cresswell St, Campbell ACT 2601, (062)48-7793, for details of membership and information on forthcoming activities.



## Tubeless CRT terminals

A tubeless CRT terminal developed by Synertek is now available from Royel Micro Systems, and offers a choice of formats.

The Model KTM-3 provides a 24-line x 40-character display, and operates with a low-cost monitor or TV. The KTM-3/80 delivers 24 lines x 80 characters, and operates with a high quality CRT monitor. Aside from the number of characters displayed, the units have identical technical features.

The terminals generate the full ASCII upper and lower case alphanumeric character set with descenders, using a 7x9-dot

character matrix. Also available are control characters, scrolling, a blinking cursor, full cursor control, absolute and relative cursor addressing, automatic character repeat, and a shift lock key.

Further information is available from Royel Micro Systems, 27 Normanby Road, Notting Hill Vic. 3168, (03)543-5122, and 15/59 Moxon Road, Punchbowl NSW 2196, (02)709-5293.

## 1M-bit bubble memory

National Semiconductor Corporation has begun shipping prototype quantities of 1M-bit bubble memories and expects to begin volume shipments later this year.

National has been making volume shipments of 256K-bit magnetic bubble memory systems since November 1980, and recently introduced the smallest, densest five-chip support circuit set available in the marketplace today.

The company and its second sources are the only suppliers of bubble memory circuits and controllers able to offer a compatible

256K-bit and 1M-bit family of components, kits, boards and bubble memory subsystems.

National's three-year-old multi-million dollar memory programme has developed the smallest bubble memory devices available. A 1M-bit system is contained on a nine-square-inch card, or a full megabyte on an 81-square-inch standard BLC (Series 80/Multibus) board.

## Pennywise three-card system

Australian designer Pennywise Peripherals can now offer a complete 64K 6809 disk-based system on just three pc boards.

The release of their new 64K CMOS static RAM card, the M16-64, has completed the three-card system, and uses the latest 2K by 8-bit RAMs with an access time of 200 ns and very low power consumption.

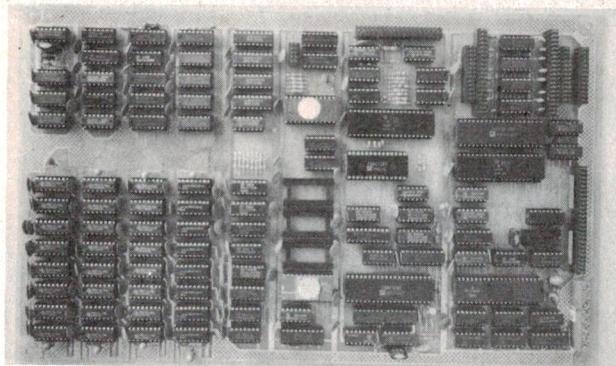
The other two cards are the PMC-09 7809 Microcomputer Card, with memory management hardware essential for multiuser operation, and the FDCP-58 Floppy Disk Controller Card, which controls any

mixture of 5" or 8" double-sided floppy disk drives.

This three-card system means that in a development system only three edge connectors are occupied, leaving plenty of space for development.

For more information contact Pennywise Peripherals, 96 Camberwell Rd, Hawthorn East Vic. 3123 (P.O. Box 398, Camberwell Vic. 3124). (03)82-2389.

# Printout



## 'Big Board' computer kit has many features

Rod Irving Electronics is offering a Z80 CPU board with 64K of RAM and a huge variety of features for around \$700.

Using 'industry standard' 4116 RAM chips, all 64K is available to the user — the video and EPROM sections of the computer do not use any of the system RAM. The Z80 CPU runs at 2.5 MHz and supplies all the 4116 RAM refresh signals, and is claimed to support mode two interrupts.

The basic I/O consists of a parallel port for use with an ASCII-encoded keyboard input; output is to standard 80 x 24 video display. The character set is supplied on a 2716-style EPROM and you can organise your own video configuration if you wish. A floppy disk controller is provided, IBM 3740-compatible, on board.

The 2K system monitor includes dump memory, CP/M boot, copy, examine, fill memory, test memory,

goto, read and write, I/O, disk read and search, etc. The monitor does not occupy any of the system RAM.

Options you can obtain include serial I/O for synchronous and asynchronous communication; you can get RS232, and you can add a real time clock (Z80 CTC), four-bit parallel I/O and CP/M 2.2 Micronix Systems disk operating system.

Complete documentation is provided. You can obtain manual and assembly instructions for \$15, refundable on purchase of the board, according to Rod Irving.

The 'Big Board' measures 216 x 350 mm and requires a power supply of +5 V at 3 A and -12 V at 1/2 A.

Further details from Rod Irving Electronics, 425 High St, Northcote Vic 3070. (03)489-1923.

### Software Source

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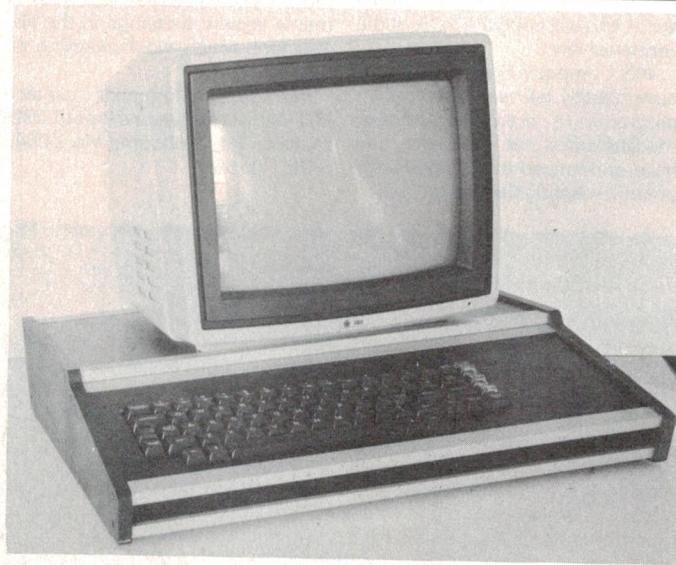
## Brisbane conference

The Institute of Engineers Aust., in association with the Australian Computer Society and the Institute of Radio and Electronics Engineers, will be hosting a conference on microprocessors in Brisbane from 17 to 19 November.

The venue is the Bardon Professional Centre in Simpsons Rd, Brisbane. An exhibition by major manufacturers and distributors will be held concurrently with the conference. Registration for members of the above societies for the full conference is \$130. Details from

the secretaries of the mentioned societies.

A free public session will be held on the 17th at the Bardon Centre, commencing at 7.30 pm. If you're going to be in Brisbane, don't miss it.

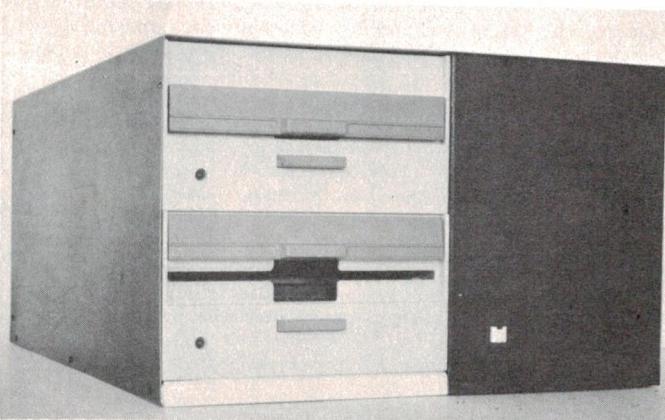


## Disk-based system from Ritronics

Melbourne-based Ritronics are manufacturing a disk-based computer system featuring 1.2M (formatted) capacity, parallel and serial interfaces, CP/M 2.2, an 18 MHz green screen monitor and full-size keyboard.

The system features a Z80 CPU board with 64K of RAM, and Rod Irving has put it on the market for just under \$3000 (plus tax), assembled and tested, with a 90-day warranty. A variety of software is available for the machine, including the popular Wordstar word-processing package. Documentation available with it even includes circuitry. Technical back-up is available for customers.

Full details can be obtained from Ritronics, 425 High St, Northcote Vic 3070. (03)489-7099.



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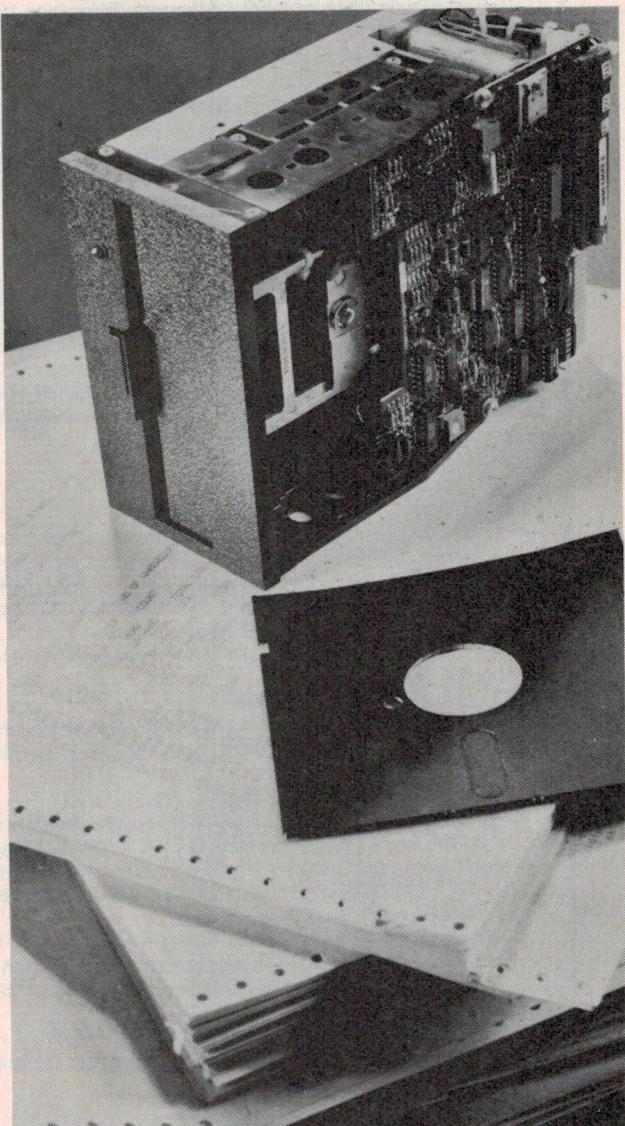
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SN 781

## For Sorcerer Apprentices

We'll start with a letter I received recently:

Dear Sir

I am most grateful for publication of those locations which address the entry points of the LOG, SIN, etc, subroutines of the BASIC PAC. I am pleased to supply you with information on how the floating point format is set up in locations 1BF through 1C2.

The exponent is stored in location 1C2 and the mantissa in 1BF through 1C1, with the most significant byte in location 1C1. The binary point is shifted to the leftmost position.

For example, the mantissa for 43.5 decimal is 2B.8 hex, which is 00101011.1 binary. This number will be stored in location 1C1 1C0 and 1BF as follows:

1010 1110 0000 0000 0000 0000

and we assume that the binary point is in front of that number. But since the digit to the far left of the mantissa is always 1 (because it was shifted until that was the case), then the sign can be stored in this bit without losing any information. If the number is positive or zero, then the sign bit will be 0; if negative, the sign bit will be 1.

Therefore the mantissa for 43.5dec:

1010 1110 0000 0000 0000 0000

changes to:

0010 1110 0000 0000 0000 0000

If the mantissa were negative, then the mantissa would not change.

The exponent is stored in location 1C2 and is calculated by adding the number of shifts to 80hex. If the shift is to the left the number will have a positive sign; if the shift is to the right, the sign will be negative. In the case of 43.5dec we shifted the binary point 6 places to the left, and therefore the exponent is  $80+6=86$ . Now we can assemble the complete floating point number in the input/output buffer as follows:

86 2E 00 00

Exponent sign & mantissa

Implied point

Please note that the number is always in memory in reverse

In example 1 the decimal number 43.5 was entered in the buffer and a call was made via the monitor. After the call to location D4ABhex was completed, the program returned to the monitor. When inspecting the buffer the answer was 82 71 74 EBhex.

The conversion of the mantissa of the above answer into a binary number will give:

0111 0001 0111 0100 1110 1011.

This is a positive number and, as we remember from above, the most significant digit is always a 1. Therefore the actual number will be converted to:

1111 0001 0111 0100 1110 1011

Since the exponent is 82 the binary point must be shifted two places to the right; the final result is therefore 3.C5 D3 AChex. Converting the number to decimal will give  $3 + 12/16 + 5/256 + 13/4096 + 3/65536 + \dots$  LAST FRACTIONS. Adding the number and fractions together we get 3.7728dec, which is correct.

In the example 2 the floating point number 82 00 00 00hex (2 decimal) was entered in the buffer. When a call to location D4ABhex (LOG) was carried out, the content of the buffer was 80 31 72 18hex or 0.6931 decimal.

Below are a few examples showing how the decimal number is converted and placed as a floating point number in the buffer of the BASIC PAC:

1196 =	4AChex	= 8B 15 80 00
1 =	1	= 81 00 00 00
-1 =	-1	= 81 80 00 00
-0.5 =	-0.8	= 80 80 00 00
0 =	0	= 00 61 00 00

The only special case is the number 0; here the exponent is 00.

### Example 1

>EN 1BF

01BF: 00	01BF: 00
01C0: 00	01C0: 00
01C1: 2E	01C1: 00
01C2: 86	01C2: 82

### Example 2

>EN 1BF

01BF: 00	01BF: 00
01C0: 00	01C0: 00
01C1: 00	01C1: 00
01C2: 82	01C2: 82

01C3: /

>GO D4AB

>DU 1BF 1C2

01BF: EB 74 71 82 8F

01C3: /

>GO D4AB

>DU 1BF 1C2

01BF: 18 72 31 80

I hope this is enough information for your readers who want to make use of the subroutines resident in the BASIC PAC.

**R. Perkuhn, Dapto**

Well, 'R', thank you very much for all that information; I'm sure lots of readers will find it all extremely useful. Keep up the good work.

Now I'm going to get into some more ways to help you understand that wonderful little machine of yours. As mentioned in last month's issue, the Sorcerer is becoming more and more attractive for small business users and hobbyists alike, with an ever-increasing myriad of new programs appearing on the market. Most major programs are disk programs, and so the next section deals entirely with disk programs. Again, all information relates to the CP/M 2.2 operating system.

The main problem I encountered during my changeover to disks was the perplexity and vastness of information suddenly thrust upon me. What are BDOS, BIOS, FDOS, TPA, CCP etc. etc? Well, here goes:

**BDOS:** (Basic Disk Operating System). The BDOS handles all disk file management functions, such as opening a file, allocating free disk areas to files and keeping track of these areas. Since all this is quite complex, we are not interested in it, and so the BDOS does not normally echo anything to the screen; exceptions are error messages, such as disk full or disk r/o (read only).

**BIOS:** (Basic Input/Output System). Note that the word "basic" does not have any connections with the programming language. This is the part of CP/M which is customised to your own requirements. One can install special printer routines, a screen save routine or even a sort routine, all depending on the individual's requirements. The BIOS should however not be tampered with until a thorough understanding of the CP/M operations is reached.

**FDOS:** The memory area occupied by BDOS and BIOS. This area must remain intact during execution of programs accessing disks and can be found by checking bytes 6 and 7. These bytes point to the beginning of the BDOS (in reverse).

**TPA:** (Transient Program Area). Starting at location 100hex to FDOS. This is where your application programs will load. The TPA may extend into the CCP as long as the CCP will be rewritten for the next CCP access.

**CCP:** Console command processor. This area processes the commands you keyed in. If you use an inbuilt command, e.g.: DIR<CR>, CCP will not load any program but simply show the files on disk. If you key in PIP<CR>, CP/M will load the program called PIP at the TPA and then jump to the TPA. One neat trick possible here is to save a zero length file (e.g.: save 0 @.com<CR>). Next time you want to run the same program twice, instead of loading it the second time, simply enter: @<CR>; this will load 'nothing' into the TPA and jump to it! Try it with PIP. Not all programs will run a second time; such programs would have up- or down-loaders, and therefore their "goaddress" would not be 100h. You'll get to know which of your programs can be tricked this way and which cannot.

Lots more jargon is available for those of you already conversant with CP/M, but, as a beginner, that's all you really need to know. The more important thing is to recognise what the different type of files on your disk are meant to be. The first eight characters are unimportant. In the next section, we deal solely with the file-name's 'extension', the 3 characters after the point:

**\$\$\$\$:** Temporary CP/M files; erase them if you see any on your disk!

**ASM:** Assembler file — an ASCII file containing Z80 or 8080 mnemonic instruction, to be converted by an assembler into a ".HEX" or ".REL" file.

**BAK:** Backup file, created by programs like Spellbinder, Wordstar, etc.

**BAS:** Basic file, either ASCII or non-ASCII.

**BCK:** Backup files, created by 'Screen-saver'.

**C :** BDS C Source file — an ASCII file to be converted into a ".CRL" relocatable file.



## New TeleVideo terminal

A new multi-lingual compatible and conversational terminal manufactured by TeleVideo has been released on the Australian market by Anderson Digital Equipment.

The new 910 conversational terminal is compatible with a range of other terminals, and allows the user to speak in English, French, Spanish or German by the use of strappable connections. Quality and legibility are also said to be improved.

ADE has developed a marketing strategy known as the 'Six-Pack Special', whereby purchasers buying lots of six get them for the

price of less than five. The normal single-unit price is \$995, but in lots of six the units are priced at \$850 each—a total saving of \$870 for the six units (this includes duty, but not sales tax).

Anderson Digital Equipment has branches and offices in every state, or may be contacted at P.O. Box 422, Clayton Vic. 3168. (03)544-3444.

## New Fairlight releases

Fairlight's new word processor, the Lightwriter, is not a general microcomputer with a new software package, but a professional word processor designed from scratch. Both software and hardware have been developed especially for the needs of the office environment.

Amongst several innovative features is a lightpen, which provides text marking, movement or command selection on the face of the video screen. The operator points the pen at the desired line, word, paragraph or command word and touches it with the tip of the pen to activate it.

The Lightwriter also has a 15" screen, which gives a 50% larger character area than conventional 12" displays. This is claimed to result in a significant reduction in operator eyestrain and fatigue.

BASIC and various high-level languages are available, and the Lightwriter uses two 8" double-sided floppy disks, each capable of storing 200 pages of text. Two independent printers can be plugged into the Lightwriter, so that either high-quality documents or high-speed drafts can be selected without any switchover.

According to Fairlight, the Lightwriter is the first of a family of Australian-made word processing

products, and pricing starts at \$9000 plus printer. Due to its local construction, duty is not applicable.

Fairlight has also developed its QASAR single-user computer into a multi-user system, called the QASAR/VS, which is described as an entry-level system catering for one to four on-line users.

The new operating system design, commands and utilities are similar to those on the single-user QASAR, so that the latter now has a growth path; considerable effort has been made to maintain a high degree of commonality.

High-level languages include Pascal compiler and BASIC compiler with compatible interpreter, and FORTH is expected to be available by the end of the year.

When production units become available in November, it is expected that the system price will range from \$10 000 to \$16 000 plus terminals and sales tax. Fairlight also offers a two-year warranty, claiming to be the first supplier to do so.



## Dragon to slay foreign competition

A new Australian-designed microcomputer, the Dyad Dragon, was recently launched in Melbourne by Professional Australian Systems, and is said to have been designed to meet the specific needs of Australian schools.

The designer, Mr. Bill Penrose, said that the Dragon should, "compete by price and quality against the best of the overseas manufacturers can throw against us."

The Dragon is designed to meet any school's needs for both computer education and school administration, and because of its modular design it can be added to a school's existing hardware without the need for expensive modems, software or interface cards.

The basic system, which retails for under \$2500, includes a CPU, card reader, automatic card hopper feed, 16K of RAM (upgradeable to 48K), video screen, keyboard and cassette interface. A cassette recorder, dual disk drives with 630K of information storage and printers are also available.

The Dyad Dragon is to be distributed in Australia by Zephyr Products, 70 Batesford Rd, Chadstone Vic.

- .COM:** command files. These files auto-execute when called from disk, e.g. PIP.COM.
- .CRL:** BDS C—relocatable file, to be converted into a ".COM" file by the BDS C linker-loader.
- .DAT:** Data files, any type of application.
- .DIC:** Spellcheck dictionary file.
- .DOC:** Documentation file; read them when you get new programs.
- .EZY:** Bob Stafford's EZYFILE data files.
- .HEP:** Spellbinder Help files, containing operating instructions.
- .INF:** Information file, same as ".DOC" files.
- .INS:** Instruction file, containing instructions on program operations.
- .INT:** C-Basic intermediate file.

- .LEX:** Microspell lexicon file.
- .LIB:** Library file, containing standard or customised routines, created with LIB or other programs.
- .MAC:** Macro-80 Source file, same as ".ASM".
- .OVR:** Wordstar overlay file, similar to ".COM" files, but loaded in different locations.
- .PRN:** Print file, created by assemblers.
- .REL:** Relocatable file, created by assemblers.
- .SUB:** Submit file, containing a batch of instructions.
- .TXT:** Text file, normally for demonstration.
- .UTL:** SID utility file.

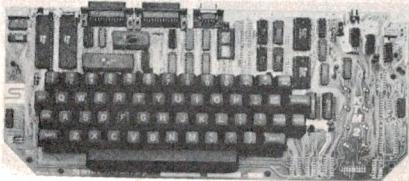
I hope that helps all beginners with disks; that's all for this month.

A.P.F. Fry

AIM65

SYM-1

### AFFORDABLE INSTRUMENTATION



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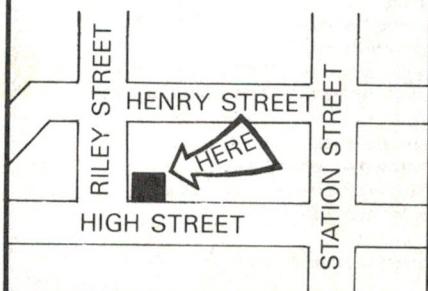
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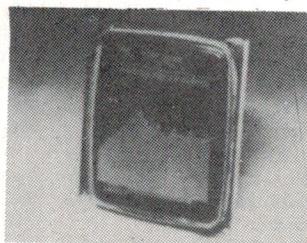
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# Programming in CHIP-8

## — a crash course

(what to do with your ETI-660 while you're learning how to do things with your ETI-660)

The 'language' used by our ETI-660 Learners' Micro-computer is called CHIP-8. It was developed by the designers of the 1802 microprocessor as an aid to writing small programs. Phil Cohen takes a look at CHIP-8 and gives a few programs for you to explore.

FIRSTLY, I should really tell you what CHIP-8 is *not*. It's not a high-level language like BASIC or even FORTRAN. Programs written in CHIP-8 are almost indecipherable to the casual reader. In that respect it is very much like 'machine code' — which is the 'language' that the microprocessor itself uses.

CHIP-8 is one step removed from that primitive machine code. What happens is this: you write a program in CHIP-8, and put it into an area of the ETI-660's RAM memory. Then you tell the microprocessor (by means of the built-in 'monitor' program located in IC11 that I'll also describe in this article) to go to the area of ROM memory that CHIP-8 resides in. The information in the CHIP-8 'interpreter' will tell the microprocessor how to do the CHIP-8 *program* that you've entered.

So why not write your programs in machine code in the first place and be done with it? Well, CHIP-8 offers some facilities (especially in input and output) that are difficult to design into a machine code program (especially for a first-timer).

If the last few paragraphs have 'lost' you, then don't worry. I'm just about to repeat myself in simpler terms.

When you turn on your ETI-660, the computer will be in the control of the 'monitor'. By operating the buttons on the unit, you can make the machine store a sequence of bytes of information in its memory.

Having done that, you then tell the monitor to hand over control to the CHIP-8 interpreter. The CHIP-8 interpreter follows the 'program' that you typed in using the monitor. The program can be anything from a TV game to a reaction timer.

How do you know what bytes of information to store in order to make the machine perform a particular series of actions? — that's easy. You read the rest of this article!

### The monitor

Before I go on to the CHIP-8 interpreter proper, I'll just quickly cover the various commands that the monitor program is capable of understanding.

On the ETI-660, there is a RESET button. Now, no matter what happens, pressing the RESET button will get you back to the state where you were when the machine was first turned on. If after the monitor has passed control to the CHIP-8 interpreter, things start to go wrong (the thing gets into an endless loop, for example), then all you have to do is to press the RESET button and you'll be back in the monitor again.

Now, the first command that we'll cover is the **'Memory Inspect and Modify'** (MI&M for short). This command is started by pressing key 0. The machine must just have been RESET.

When you press RESET, four digits will appear on the screen. This four-digit number is an 'address' — the number corresponds to a 'location' of RAM. Each 'pigeon hole' in the ETI-660 RAM memory has a four-digit number allocated to it.

In order to change the number on the screen, press key 0, followed by four digits.

Once you have done that, you can find out what the contents of the memory location are by pressing one of the STEP buttons (either one — they're connected in parallel). The two-digit number that appears is the value held in the location whose address you entered.

Pressing the STEP button again will show you the next location. Pressing it repeatedly will 'step' you through memory.

You can change the contents of any location by putting its address on the screen, and then entering the value that you want using the keyboard.

You can enter a series of values into successive memory locations by press-

**Phil Cohen**

ing STEP between entries. So to enter 12 into location 0600, 34 into 0601, and 56 into 0602, you would press RESET, then 0, then 0600, then STEP, then 12, STEP, 34, STEP, 56.

You can get out of MI&M mode by pressing RESET — this will not affect the values that you've put into memory.

The numbering system used is base 16, or hexadecimal ('hex' for short), rather than the more usual base 10 (which we were all taught at school). If you don't understand base 16, wait until the 'simple' series of articles on programming which will follow this crash course'.

So, after you've worked out what the various bytes of your CHIP-8 program are to be, you can enter them into memory using MI&M.

Once you have entered them, you can pass control to the CHIP-8 interpreter by pressing key 8 (after the machine has been RESET).

The CHIP-8 interpreter will look for the first CHIP-8 instruction at memory location 0600. The locations available to you to use for a CHIP-8 program are from 0600 to 07FF — that's over 500 locations.

### Storing on cassette

Now, if you turn the machine off, you will lose the program that you just typed in. This is not good, especially if it happens by accident.

You can **store your program onto cassette** by the use of key number 2. What you do is this: put the location at which the program starts into locations 0400 and 0401.

All your CHIP-8 programs will start at location 0600, so that means setting location 0400 to 06, and location 0401 to 00.

Similarly, set locations 0402 and 0403 to the end location of your program. 07FF should cover it. Press RESET, then start your cassette running and press button 2. As the

## STORING ON/LOADING FROM CASSETTE

**To Store:** Having typed in your program and got it running, you'll want to store (or save) it on cassette. Say the program runs from 0600 (in RAM) to 0725 — like the 'Target Practice' example later. First, press RESET, then press 0. Now, press

```
'0400'  
'STEP'  
'06'  
'STEP'  
'00'  
'STEP'
```

The address section in the bar at the bottom of the screen should now show '0402'. Continue with:

```
'07'  
'STEP'  
'25'
```

As a precaution, to avoid 'chopping off' the end of your program, you could make the last entry 'FF' if you like.

Then, press RESET. Connect up your cassette recorder — TAPE OUT to the 'mic' jack and TAPE IN to the 'ear' jack, and insert a fresh cassette. Set your cassette deck recording and:

press '2'

The speaker in the 660 will emit a series of outrageous noises. The TV screen will go blank, too. When the noise stops, STOP your cassette recorder. The TV screen will come back to life. Rewind your tape. Turn the power to the ETI-660 off briefly, then on again. Now you can try the next bit.

**To load:** Rewind your tape, if it isn't already rewound, or set it to the vicinity of the tape prior to where you recorded the program. You have to set the memory location 0400 to the start of the program (usually 0600) and 0402 to the end of the program — or beyond that (if you want to be safe). Taking the 'Target Practice' program:

press

```
'RESET'  
'0'  
'STEP'  
'0400'  
'06'  
'STEP'  
'00'  
'STEP'  
'07'  
'25'
```

(or you could put 'FF' here)

```
'RESET'  
'4'
```

The TV screen will go blank. Now start the cassette deck in PLAY. Set the volume control well up. Some experimentation with the volume control may be necessary to achieve a successful load. As the program is loaded, the speaker in the 660 will make funny noises. The TV display will come back on and the sound will stop when the load is finished. STOP the cassette deck. Press RESET and then 8 and your program is up and running!

**Troubles:** Your cassette deck should be in good condition, with clean unmagnetised heads properly aligned. If it cannot adequately record or reproduce 10 kHz then have it serviced or get another cassette deck. We recommend you also read 'Reliable Cassette Recorder For Your Computer' by Graham Wideman, September '81 ETI.

If all is OK with the deck, the record level may be too low. Listen to the tape once you've stored a program. The signal should be loud and with little or no background noise. If the record level is too low then reduce the value of R25. About 2k should more than cover it.

Most troubles with the cassette interface may be traced to head alignment or magnetisation problems, and unreliable connectors.

program loads, you'll hear an outrageous noise from the speaker. When the noise stops, stop the tape.

Putting your program onto tape is fine — but how do you get it off? Simple. Use key 4. This **loads the taped program into memory**.

Press the RESET key, and then press key 4. Then set the cassette going. As the program is loaded in, the tone being put out by the ETI-660 will change. When the TV display comes back on, it's finished. Stop the tape.

There is a further command, key 6, and this allows you to **execute a machine code program** at the address shown on the TV. However, the use of this is a little difficult. In other words, I haven't got room in this article to explain the 1802's instruction set, so I'll leave that one till later.

## CHIP-8 proper

Fine. Now you're quite happy about what to do with your CHIP-8 program once you've written it. All you have to do now is to find out how CHIP-8 works. You use key 0 to enter it, then press key 8 to run it.

Each CHIP-8 instruction is two bytes long.

Take a look at Table 1. Don't expect to understand it, just take a look at it.

Looks complicated, doesn't it? Well, at first it is. But we'll split it into easily digestible chunks.

Before I tell you how the instruction set works, I'd better tell you how the table works. Each four-digit code in the leftmost column is one of the instructions. Now each instruction is two bytes long. That's four hexadecimal digits.

Taking the first instruction first (makes sense?), the code is 0MMM. Now this could be anything from 0000 to 0FFF. What I'm trying to get over by putting the Ms in is that where an M appears, you could have anything from 0 to F.

The mnemonic is just a way of showing the same thing in a more readable form. So the mnemonic for 0123 would be CALL 123. This would make the machine jump to a machine code subroutine at 0123 (the locations that it will jump to will always start with 0 because of the small size of the system).

So if you wanted to make the machine jump to a machine code subroutine (doesn't matter that you don't know what a subroutine is just yet) at location 0456, you would write CALL 456 down when you were planning your program, and when the time came to enter it into the machine, you would put in 0456.

By the way, as each instruction in CHIP-8 takes up two bytes, it takes two operations of the STEP key to input each full instruction.

So if the first instruction in the program (which, remember, starts at location 0600) was to be a CALL 456, then what you would do would be to press the RESET button, then press 0, then enter 0600, then press STEP, then enter 04, then press STEP again, then enter 56. And so on for the rest of the program.

Now I'll start describing the instruction set. I'll put the name of each instruction in **bold** type as I come to it, so that you can find it quickly later.

The first instruction is, of course, the **0MMM**. I've more or less covered this one — all that it does is to send the machine to a *machine code* routine. As I haven't told you how to write machine code routines, I'll leave it at that.

The next instruction is **1MMM**. This causes the CHIP-8 interpreter to jump to location 0MMM for the next instruction. Now normally, the interpreter will do the instructions in the order in which it finds them in memory, starting at location 0600, then 0602 (two locations per instruction, remember), then 0604, etc. But say you want it to go into a 'loop', repeating the instructions in locations 0600 to 0608 endlessly?

The answer would be to put an instruction in 0608 that causes the normal sequence of the 'execution' of the instructions to be changed. If you put a 1600 in location 0608 (and the mnemonic for this would be GOTO 600), then the machine would do the instruction in location 0600 at the start of the program, then 0602, then 0604, then 0606, then it would come to 0608. Following the GOTO instruction, the next one it would do would be 0600 again, followed by 0602, 0604, 0606, 0608, then back to 0600, 0602 ... and so on.

Of course, the GOTO instruction can not only make the interpreter jump *back* in the program — it can also make it jump forward.

## Subroutines

The next instruction we come to is one of the most complicated. It's the **2MMM** instruction — the DO MMM.

Now what this tells the machine to do is similar to the effect of the GOTO MMM instruction. The difference is that, whereas when it got to a GOTO MMM, the computer goes where it's told, with a DO MMM it remembers where it jumped from. So for example, you might have a segment of program somewhere in memory that does something useful that you want to do quite often from different parts of the program. A program segment like that is called a subroutine (for historical reasons).

The DO MMM instruction allows you to send the machine out of the main part

of the program to the start of that subroutine, and a special instruction at the *end* of the subroutine will send it *back* once the subroutine is finished.

The special instruction is 00EE. So, for example, the following sequence will cause the subroutine to be done twice at different parts of the main program (the dots '...' mean various program instructions that aren't important to what I'm showing you):

location	code	mnemonic	comments
0600	...		
0610	2640	D0 640	first 'call'; <b>main program</b>
0624	2640	D0 640	second 'call'
...	...		
0640	...		
...	...		
0652	00EE	RET	<b>subroutine</b> sends it back

TABLE 1 — CHIP-8 INSTRUCTION SET

CODE	MNEMONIC	FUNCTION
0MMM	CALL MMM	jump to a machine code subroutine at location 0MMM. The subroutine must end in a RET (D4)
1MMM	GOTO MMM	jump to location 0MMM (at which the next CHIP-8 instruction is to be found)
2MMM	DO MMM	jump to a CHIP-8 subroutine at location 0MMM. The subroutine must end in 00EE (which is the CHIP-8 equivalent of RET)
3XKK	SKIP IF VX=KK or SKF VX=KK	skip the next instruction if variable VX holds the value KK
4XKK	SKIP IF NOT VX=KK or SKF VX=KK	skip the next instruction if variable VX does <i>not</i> hold the value KK
5XY0	SKIP IF VX=VY or SKF VX=VY	skip the next instruction if variable VX holds the same value as variable VY
6XKK	VX=KK	set variable VX to value KK
7XKK	VX=VX+KK	add KK to the value at present in VX
8XY0	VX=VY	set the value of VX to that in VY
8XY1	VX=VX OR VY	logical OR VX with VY, put the result into VX. Logical OR is like putting the two binary values through an OR gate bit by bit
8XY2	VX=VX AND Y	same as 8XY1, but logical AND
8XY3	VX=VX XOR VY	same, but with logical exclusive OR
8XY4	VX=VX + VY	add VX and VY, put the contents into VX. If there is an overflow, VF becomes 01, otherwise it becomes 00
8XY5	VX=VX - VY	subtract VY from VX and put the result into VX. If there is an underflow, VF becomes 00, otherwise it becomes 01
9XY0	SKIP IF NOT VX=VY or SKF VX=VY	skip the next instruction if the value of VX is not the same as that of VY
AMMM	I=MMM	set the value of the special 'memory pointer' variable I to 0MMM.
BMMM	GOTO MMM + V0	the value in variable V0 is added to 0MMM, and the machine will jump to the location whose address is the result of the addition
CXKK	VX = RND AND KK	produce a random byte, logical AND it with KK, and put the result into VX
DXYN	SHOW N AT VX, VY	starting at the address held in the 'memory pointer' variable I, or SHOW N@VXVY take N bytes out of memory and put them on the screen at a position VX from the left and VY from the top
EX9E	SKIP IF VX=KEY or SKF VX=KEY	skip the next instruction if VX is equal to the key being pressed
EXA1	SKIP IF NOT VX=KEY or SKF VX=KEY	opposite of EX9E
FX00	PITCH = VX	set the pitch(i.e: frequency)of the tone generator (beeper) to VX
FX07	VX = TIME	set VX to the current timer value
FX0A	VX = KEY	wait for a key to be pressed, then put the value of the key in VX
FX15	TIME = VX	set the value of the timer to VX
FX18	TONE = VX	set the duration of the tone burst (length of beep) to VX times 20 milliseconds (when VX is 50, it will be one second)
FX1E	I = I + VX	increase the value of the memory pointer by VX
FX29	I = DSPLY VX or I = DSP, VX	set the value of the memory pointer I so that when the next DXYN instruction is executed, the pattern shown will be the number that is the least significant digit of VX.
FX33	M(I)=DECML VX or MI=DEQ, VX	convert the value in VX to a three-digit decimal (base 10) number, and store the three digits in memory locations starting at location I (i.e: I, I+1 and I+2)
FX55	M(I)=V0:VX	put the values of variables V0 through VX into memory, starting with V0 at location I, V1 at location I+1, etc ... up to VX. Then increase the value of I so that it is I+X+1 (i.e: so that it points to the next location above the ones used for the variables)
FX65	V0:VX=M(I)	take the values of variables V0 through VX <i>out</i> of memory in the same way as the FX55 instruction. I becomes I+X+1. V0 comes out of location I.

When the machine got to 0610, it would immediately jump to 0640, then it would do 0640, 0642, 0644, ... and when it got to 0652, it would jump back to 0612 (the instruction *after* the one that 'called' it).

It would then go 0614, 0616, ... and when it got to 0624, it would again jump to 0640, go through the subroutine again, and when it got to 0652, it would jump back to 0626 — the instruction after the one that it was called from.

You can see that, by using this sort of thing, you can put in subroutines (sometimes called 'routines' for short) to do all sorts of useful things. They would of course have to be saved on tape with the main program.

## Variables and loops

The next instruction is the 3XKK. Before I go too far into this one, I'll explain about the interpreter's **variables**.

Now the names of these variables are V0, V1, V2, V3 ... up to VF (there are sixteen altogether, and the second digit of the name of each of them is a hexadecimal one).

Each of these variables can 'hold' a value one byte long. That is, each of them can hold a value from 00 to FF.

Now the value of each of these variables can be changed at any time during a program. If you like, they're like sixteen little blackboards, each with a number written on it (from 00 to FF).

Each of the blackboards has a name — the first one is V0, the next V1 ... and so on up to VF.

Some of the instructions that the machine can execute allow new numbers to be written into the variables. Of course, when you write a new number in, the one that was there before will disappear (each blackboard can only hold one number at a time — I said they were *little* blackboards).

Other instructions allow the values in the variables to be read, added together, subtracted, etc.

So let's take a look at the 3XKK instruction. What it says is "skip the next instruction if the value in VX is KK". The mnemonic is SKIP IF VX=KK, or if you want a shorter one (and a mnemonic is only for *your* convenience, the writer of the program), then another one is SKF VX=KK.

Now the 'X' in 3XKK tells the machine which of the sixteen variables you're talking about. So 3245 would mean "skip the next instruction if variable V2 was equal to 45 (hex)".

The usefulness of this sort of instruction is in 'loops'. If you want to repeat a series of steps in a program a definite number of times, then you could set V2 (for example) to 0 at the start of the program, then do the sequence you wanted to repeat, then have an instruction that increased V2 by 1 (and we'll come to such an instruction later), then have a 3205 instruction.

The 3205 would skip the next instruction if V2 held the value 05. The instruction after the 3205 would be a GOTO MMM instruction which would send the machine back to the start of the sequence that was to be repeated.

So the first time the machine went through the sequence, V2 would be 00 until it got to the instruction to add 1 to it. It would then be 01, and when it got to the 3205, it would look at the value of V2 and see if it was 05. It wouldn't be (we've just shown that it would be 01), and so it would do the next instruction, which would be the GOTO.

That would send it back to the start of the repeated instructions (we say "back round the loop"). When it came to the instruction that added 1 to V2, it would leave V2 with the value 02.

See what's happening? Each time it goes round the loop, V2 increases in value by 1, until finally it gets to the value 05. This time, when it comes to the 3205 instruction, it would look at the value of V2, see that it was 05, and skip the next instruction (which is the GOTO). So it would not go round the loop again.

Effectively, what the 3205 instruction is doing is to tell the machine to repeat the loop 5 times.

Anyway, that's what the 3XKK instruction does.

The 4XKK instruction does much the same, except that it will skip if VX is not equal to KK.

The 5XY0 compares the values of two variables, VX and VY. So a 5670 would skip the next instruction if the value in V6 was equal to the value in V7.

The 6XKK sets VX to the value KK. If you like, this tells the machine to write the value KK on blackboard VX. 6789 would tell the machine to write the value 89 in variable V7. Another way of saying that is to say "set V7 to 89".

## Increment/decrement

The 7XKK is the one we mentioned earlier (honest) that allows you to increase the value held in VX by KK. So a 7201 would add 1 to the value stored in V2, and put the result back into V2. In other words, it would increase the value

of V2 by 1. Another name for this is 'incrementing' (no, that's nothing to do with the police interrogations). We can say that the instruction increments V2.

The opposite of incrementing, by the way (decreasing the value of a variable by 1) is *decrementing*, and not excrementing.

## Manipulations

The 8XY0 instruction sets variable VX to the value that is stored in VY. So if V2 was 03 and V4 was 89, an 8240 instruction would leave V2 at 89 and V4 at 89 also. (It's worth sitting down and thinking about that one).

The 8XY1, 8XY2 and 8XY3 instructions are very similar. Each one of them takes the values in VX and VY, does something with them, and puts the result back into VX.

The 8XY1 does a logical OR on the two values. Now in order to explain this one, you have to convert the hex values that we usually work with back into binary.

Let's say that the value in V1 is 34, and the value in V2 is 9A. That gives them the following binary values:

variable	hex value	binary value
V1	34	00111000
V2	9A	10011010

Now what the 'logical OR' does is to take corresponding bits of the values of V1 and V2 and put them through an OR gate. Starting from the left, 0 OR 1 would give 1; 0 OR 0 would give 0; 1 OR 0 would give 1; and 1 OR 1 would give 1; and so on.

So the result would be 10111010, which in hex is BA. That's how it works. The usefulness of it is that for example, 40 OR 08 is equal to 48.

The logical AND (8XY2) works in much the same way, except that it puts the individual bits through an AND gate (metaphorically). The usefulness of that is that 48 AND F0 is 40; 48 AND 0F is 08.

The last one, 8XY3, gives a rather weird function (again bit by bit) called 'exclusive OR', or 'XOR' for short. What this says is that the result will be 1 if the inputs are different. So 1 XOR 0 is 1, but 1 XOR 1 is 0.

## Plus and minus

The instruction 8XY4 is quite straightforward — the value in VX is added to the value in VY, and the result ends up in VX. But what happens when you try to add F0 to 42? The result (if you work it out by hand) would be 132 (hex). Now the result is going to go into VX, and VX will only hold two hex digits. So VX becomes 32, and VF (always VF, no matter what the values of X and Y are) is set to 01.

Of course, if the result is less than 00, VF is set to 00.

8XY5 is the same as 8XY4, except that the value in VY is subtracted from the value in VX. If the result is less than 00, VF is set to 00, but if the result is not less than 00, VF is made 01.

## Skip to my loo

9XY0 is simply "skip the next instruction if the value in VX is not the same as the value in VY"— the opposite of the 5XY0 instruction.

## You and 'I'

Now comes the time to introduce the 'memory pointer', I. This is the same as the rest of the variables V0 through VF, except that it can hold three hex digits (while they can hold only two).

It needs the extra room because it is used to hold the address of memory locations, and three hex digits is the smallest useful space in which that can be done.

The AMMM instruction simply sets the value in I to MMM, so that A123 would leave I holding the value 0123.

We'll come back to the I variable later.

## Branches

BMMM is a strange one. What it says is "branch to the memory location which has the address of 0MMM plus the value of V0". So if V0 had the value 05, the instruction B610 would cause the machine to go to the instruction at location 0615.

This instruction is useful for accessing a series of short program segments arranged in a 'table' starting at 0MMM. As the value in V0 is changed, the jump will take the machine to different parts of the table. V0 is sometimes called the 'offset' and MMM the 'base' in this context.

## Randomise

CXKK is a nice one. What it does is to produce a random byte (which the interpreter does all by itself), and then to AND this random byte with the value KK and put the result into variable VX.

So C234 will generate this random variable, from 00 to FF, then AND the random byte with 34. It's worth working out for yourself, but I can tell you right away that the maximum value of the result of that AND operation will be 34. The result is then put into V2.

So what the C234 instruction says is "set V2 to a random value between 0 and 34 (hex)".

## Output and the screen

Now we come to some of the output instructions. These deal mainly with outputting information to the screen. The CHIP-8 program can, of course,

output to the screen directly by altering the memory locations which store the information that is to be displayed directly. (Each dot on the screen is one bit of memory, and the whole screen is stored in memory in a block starting at 0480). However, the CHIP-8 interpreter allows a much greater control over what's going on.

In the CHIP-8 interpreter, the screen 'locations' are split into 3F horizontally and 3F vertically. I'll explain that a bit further.

The **DXYN** instruction causes the machine to take N bytes out of memory, starting at the memory location whose address is given by the I pointer. So far, so good.

Now the DXYN causes the machine to put an image of these bytes onto the screen. What I mean by that is this: assume that the screen is blank to start with. Let's say that the DXYN is D321. So the number of bytes to be taken from the locations starting at I is 1.

Let's further say that the value of that one byte is 83. The binary for that is 10000011. The machine would put that binary image onto the screen by turning on one dot, then leaving the next five off, then turning on the next two.

By 'turning on a dot', I mean that a small part of the screen will go bright. The size of each dot is a few square millimetres (in fact, the numbers that you see when you turn the computer on are made up of these dots (also called 'pixels')).

Which part of the screen would this pattern appear in? That's where the XY part of the DXYN instruction comes in. X and Y refer to two variables. The first gives a number of dot widths across the screen, and the second gives a number of dot heights down the screen.

So let's say that the instruction was D321, and that V3 held the value 05 and V2 held the value 08. The first dot in the image would be five dots to the right and eight dots down from the extreme top left of the screen.

Now all this may seem unnecessarily complicated, but consider this: once you have set I to point at the image that you want (and set the relevant bytes of memory so that the dots you want in that image are right), changing the values held in VX and VY will make the image 'move' across the screen.

Another point I might bring to your attention is that, where the instruction is about to turn on a dot that's already on, it will turn it off. In fact, rather than saying 'turn the dot on', what I should have said was 'change the state of the dot'.

This means that the image that you put on the screen can be removed (set back to its original blank state) by executing the same DXYN instruction.

**EX9E** is an easy one. It skips the next instruction if the number on the key that you press is the same as the value in VX. This means that you can wait for a particular key to be pressed, ignoring all other keys, by making the instruction after the EX9E a jump back to the EX9E instruction (think about it).

**EXA1** is the same as EX9E, except that it will skip if the key you press is not the one whose value appears in VX.

### Play it, Sam

Another nice feature of the CHIP-8 interpreter is that it has a musical tone generator — the speaker in the machine can be made to emit a variety of musical notes.

The **FX00** instruction sets the pitch (frequency) of this tone. The X refers to one of the variables. So F200 would set the pitch of the tone generator to the contents of variable V2. The higher the value of the contents of the variable, the lower the pitch of the tone.

Once the PITCH variable (and it behaves just like a variable) has been set, all tones from the generator will be at that pitch until another PITCH=VX instruction is encountered (or the program ends).

### Period

Yet another nice feature offered by the interpreter is the timer. This is like another variable, in that the one-byte value in it can be set to a given value, and the value in it can be used to set another V-type variable.

The difference is that the value in the timer variable will reduce by one every 20 milliseconds (one-fiftieth of a second) or so.

Having set the timer with a particular value (the time that you want the program to pause for, for example), you can then arrange to check to see if the period has ended by using the **FX07** instruction. This sets VX to the current timer value.

It's then a simple matter to use a 3XKK instruction to check the value in VX to see if it's zero, looping back to the FX07 instruction each time if it is not. The "RANDOM PITCH AND BLOCKS" example program later in the article uses this trick.

### Pounding the keys

For keyboard input, the interpreter makes life really easy. The **FX0A** instruction waits for a key to be pressed, and then sets VX to the number on the key. Simple.

Remember I said that you could set the value of the timer? Well, **FX15** is how you do it. It sets the timer to the value of VX.

Having set the pitch of the tone, how do you make the thing sound? Well, the

**FX18** does this. Not only does it set the tone off, it also allows you to set the length of time that it sounds for. One word of warning, however — the program will *not* wait for the end of the beep. That means that, if you want to produce a series of beeps (as in the "RANDOM PITCH AND BLOCKS" program), you have to arrange a timer loop so that the program will wait for the beep to finish before trying to do another beep. (If it does try to do another beep, the buzzer will be reset, and the second beep will override the first, making the first one very short).

### Numbers

Remember the memory pointer? Well **FX1E** increases the value of I by the value of VX. This is useful if you want to display a large area of memory on the screen. You can move the I pointer through memory in steps of the value of VX.

The **FX29** instruction allows you to draw numbers on the screen without really thinking about it too much. What it does is to set the I pointer so that it just happens to be pointing at a block of memory which holds the *shape* of the number which is the right-hand digit of the value of VX.

To give an example, say that you want to display the number 9 at the top left hand corner of the screen. The following program segment will do just that:

mnemonic	code	comments
V1 = 09	6109	it's the right-hand digit we're interested in
V2 = 0	6200	
V3 = 0	6300	
I = DSPLY V1	F129	I will be pointing at the digit 9
SHOW 5 AT V2,	D235	It takes 5 bytes to show a number on the screen. This will show it at screen location 0, 0 — the top left hand corner.
V3		

You might like to try this segment on your machine; make the last code (after the D235) at 0000 — this will send it back to the monitor once it's finished. Try changing the values in V1, V2 and V3 to see what effect it has.

All this is fine — but what about games? Most people like to see scores, etc, in decimal, rather than in hex!

What the **FX33** instruction does is to take the value of VX and convert it to a three-digit decimal number (somewhere between 0 and 255). It then puts the result into the three memory locations which start with the one pointed to by I. (I is not altered). So location I becomes the 'hundreds', location I+1 becomes 'tens' and I+2 becomes 'units'. How do we get the values out of there? Later.

Now comes the time to introduce the concept of a 'stack'.

## Stacks

When you jump to a subroutine (remember subroutines?) you might want to 'save' the values that are in the variables at present, so that you can go on using the same variables in the main program when the machine finishes the subroutine. So there should be some way of automatically saving the values of the variables in memory while the subroutine is going on, and then retrieving them afterwards.

A stack is a place in memory where the values in variables are kept for storage (at least, that's one of the uses for it).

The important thing about a stack is that, if *during the subroutine* you want to store some more variables, the stack can accommodate them.

It works like this: first, you set I to the start of an area of memory that you know is available (0700 is a good one). Then when you execute the **FX55** instruction, the machine will start by putting the value of V0 into memory at location I.

*The value in I will then be increased by one.* That's important — I'll tell you why later.

The next variable, V1, will be put into memory at the location *now* pointed at

by I, then I is increased again. In fact, all variables starting at V0 and finishing at VX will be stored. So if the instruction is F355, variables V0, V1, V2 and V3 will be stored.

Notice that, at the end of this instruction, I will still be pointing at an available memory location (0703, in this example).

So if you now changed the values of some of the variables, you could do another FX55 and put these new values into memory at the locations after the old values. That's why it's called a 'stack' — the values are thrown into memory in the same way that a stack of magazines will pile up — one after the

other.

Now in order to get the variables out, you would use the **FX65** instruction. First you would have to set I back to the start of the 'stack', then the FX65 would pull the variables out in the same order that the FX55 pushed them in.

The value of the memory pointer I is increased by the FX65 instruction in the same way that it is increased by the FX55 instruction. In fact, the FX65 is the way that we would get out of memory the results of the FX55 instruction.

The following example will take the value that V3 is set to, and display it in decimal at the top left of the screen:

mnemonic	code	comments
V3 = 80	6380	this is the value we're trying to display
V4 = 00	6400	
V5 = 00	6500	V4, V5 are the screen position — 00, 00 is the top left
I = 0700	A700	points to a free area of memory
M(I) = DECML V3	F333	this is the actual 'guts' of the program, and it puts the three 'results' digits at 0700, 0701 and 0702. I is still 0700.
V0:V2 = M(I)	F265	this takes the results out and puts them into V0 through V2 (which is why we used V3 to hold the input at the first line), ready to put the first digit on the screen
I = DSPLY V0	F029	as per the last example
SHOW 5 AT V4, V5	D455	next digit
I = DSPLY V1	F129	moves the screen location along so that the next digit will not be
V4 = V4 + 04	7408	on top of the first one
SHOW 5 AT V4, V5	D455	next digit is now on the screen
I = DSPLY V2	F229	last digit
V4 = V4 + 04	7404	move screen position again
SHOW 5 AT V4, V5	D455	last digit — finished!
	0000	returns control to monitor.

## TARGET PRACTICE

0600	67 19	V7=19	0664	16 6E	GO TO 066E	06C8	6F 10	VF=10
0602	68 00	V8=00	0666	47 00	SKF V7#00	06CA	F2 65	V0:V2=MI
0604	26 C2	DO 06C2	0668	16 68	GO TO 0668	06CC	F0 29	I=DSP,V0
0606	26 DE	DO 06DE	066A	27 0C	DO 070C	06CE	DF E5	SHOW 5MI@VFVE
0608	65 25	V5=25	066C	16 10	GO TO 0610	06D0	6F 15	VF=15
060A	66 0D	V6=0D	066E	73 02	V3+02	06D2	F1 29	I=DSP,V1
060C	26 E6	DO 06E6	0670	44 00	SKF V4#00	06D4	DF E5	SHOW 5MI@VFVE
060E	D5 65	SHOW 5MI@V5V6	0672	6B 01	VB=01	06D6	6F 1A	VF=1A
0610	CD 01	VD=RND	0674	44 1D	SKF V4#1D	06D8	F2 29	I=DSP,V2
0612	3D 01	SKF VD=01	0676	6B FF	VB=FF	06DA	DF E5	SHOW 5MI@VFVE
0614	6D 07	VD=07	0678	84 B4	V4=V4+VB	06DC	00 EE	RET
0616	27 0C	DO 070C	067A	D3 41	SHOW 1MI@V3V4	06DE	A7 F8	I=07F8
0618	64 10	V4=10	067C	4F 00	SKF VF#00	06E0	F8 33	M1=V8(3DD)
061A	63 0B	V3=0B	067E	16 3C	GO TO 063C	06E2	6E 00	VE=00
061C	83 D4	V3=V3+VD	0680	60 02	VO=02	06E4	16 C8	GO TO 06C8
061E	A6 BF	I=06BF	0682	F0 18	TONE=VO	06E6	C9 01	V9=RND
0620	D3 41	SHOW 1MI@V3V4	0684	A6 BF	I=06BF	06E8	39 01	SKF V9=01
0622	6C 00	VC=00	0686	D3 41	SHOW 1MI@V3V4	06EA	69 FF	V9=FF
0624	6B 80	VB=80	0688	A6 B3	I=06B3	06EC	CA 01	VA=RND
0626	60 03	VO=03	068A	D5 65	SHOW 5MI@V5V6	06EE	3A 01	SKF VA=01
0628	E0 A1	SKF VO#KEY	068C	26 DE	DO 06DE	06F0	6A FF	VA=FF
062A	6B FF	VB=FF	068E	78 0A	V8+0A	06F2	A6 B3	I=06B3
062C	60 06	VO=06	0690	26 DE	DO 06DE	06F4	00 EE	RET
062E	E0 A1	SKF VO#KEY	0692	47 00	SKF V7#00	06F6	69 01	V9=01
0630	6B 00	VB=00	0694	16 94	GO TO 0694	06F8	16 EC	GO TO 06EC
0632	60 09	VO=09	0696	27 0C	DO 070C	06FA	69 FF	V9=FF
0634	E0 A1	SKF VO#KEY	0698	16 08	GO TO 0608	06FC	16 EC	GO TO 06EC
0636	60 01	VB=01	069A	6C 01	VC=01	06FE	6A 01	VA=01
0638	38 80	SKF VB=80	069C	60 07	VO=07	0700	C9 01	V9=RND
063A	26 9A	DO 069A	069E	F0 18	TONE=VO	0702	39 01	SKF V9=01
063C	A6 B3	I=06B3	06A0	26 C2	DO 06C2	0704	69 FF	V9=FF
063E	D5 65	SHOW 5MI@V5V6	06A2	77 FF	V7+FF	0706	00 EE	RET
0640	35 94	V5=V5+V9	06A4	26 C2	DO 06C2	0708	6A FF	VA=FF
0642	86 A4	V6=V6+VA	06A6	00 EE	RET	070A	17 00	GO TO 0700
0644	45 20	SKF V5#20	06A8	01 7C		070C	6E 08	VE=08
0646	26 F6	DO 06F6	06AA	7C FE		070E	A6 A9	I=06A9
0648	45 3B	SKF V5#3B	06AC	7C 7C		0710	DD EF	SHOW FMI@VDVE
064A	26 FA	DO 06FA	06AE	70 7C		0712	7E OF	VE=OF
064C	46 00	SKF V6#00	06B0	38 7F		0714	A6 B8	I=06B8
064E	26 FE	DO 06FE	06B2	7F 7C		0716	DD E6	SHOW 6MI@VDVE
0650	46 1B	SKF V6#1B	06B4	7C 7C		0718	6E 10	VE=10
0652	27 08	DO 0708	06B6	7C 7C		071A	60 08	VO=08
0654	D5 65	SHOW 5MI@V5V6	06B8	38 38		071C	80 D4	VO=V0+VD
0656	3F 00	SKF VF=00	06BA	38 38		071E	8F 00	VF=VO
0658	16 80	GO TO 0680	06BC	38 3E		0720	A6 BE	I=06BE
065A	4C 00	SKF VC#00	06BE	E0 80		0722	DF E2	SHOW 2MI@VFVE
065C	16 24	GO TO 0624	06C0	00 D4		0724	00 EE	RET
065E	A6 BF	I=06BF	06C2	A7 F8	I=07F8	Shoot by pressing key 3 (up), 6 (straight), or 9 (down) to hit the moving target. The bottom number shows the number of shots. Each hit scores 10 points (tip number).		
0660	D3 41	SHOW 1MI@V3V4	06C4	F7 33	MI=V7(3DD)			
0662	33 3E	SKF V3=3E	06C6	6E 1B	VE=1B			

You can try playing about with the values in V3, and also in V4 and V5 — remember that V4 is increased from its *original* value, so making it a different value to start with will move all three digits (which is just what we want).

## Miscellaneous

We've covered (phew!) all of the instructions in the table so far — but there are a few others which are actually 'machine code' subroutines built into the ROM (but don't let that stop you using them):

code	function
0000	return to monitor
00E0	clear the screen
00EE	return from CHIP-8 subroutine
00F8	turn the screen on
00FC	turn the screen off (i.e. display a blank)
00FF	do nothing

A word of explanation about these — **00FC** will cause the screen to go blank until a **00F8** is executed. This allows you time to write things on to the screen — and then turn it on all of a sudden.

However, **00E0** clears all of the dots from the screen — makes it blank until you turn some of the dots back on.

**0000** is a good one — it just finishes the program and sends you back to the monitor. For programs which do something and then stop, this is very useful.

Now, **00FF** may seem a bit useless. But it's an instruction that you will probably end up using more than any other. The reason for this is that, with a long program, if you want to put in one or two extra instructions to make the program work the way you want to, you will have to change the locations of all the program from there on. However, if you put in a few **00FF**s at various points in the program, you can get away with re-entering only a small part of the program.

Similarly, any instructions that you want to take out can be replaced by **00FF**s. All a **00FF** does is to send the machine to the next instruction.

## Examples

The first example is instructive rather than useful. What it does is to write blocks of dots on the screen, at the same time playing a sequence of notes of random pitch and duration.

If you run this program, you will find that the 'blocks' do not appear at a truly random position, but that they fall into 12 areas on the screen. This is because finding a random value and then ANDing it with the limiting value (37, in this case) does not provide a completely linear distribution. Work that one out for yourselves — maybe you could find a way of putting the blocks on the screen randomly? (Clue: you might have to use the **8XY5** instruction).

The next example is a little more advanced — what it does is to turn your keyboard into a piano! As you press the keys, you will hear notes played in the key of C major.

## A game — and colour

Included here is another, longer, example — a fully-fledged game called 'Target Practice'. It hasn't got the same level of commenting as the previous examples, so that leaves you to work out for yourself how it works internally.

The fully-optioned ETI-660 is capable of producing colour on screen — I haven't covered that this time because of lack of space, but we'll get to it later.

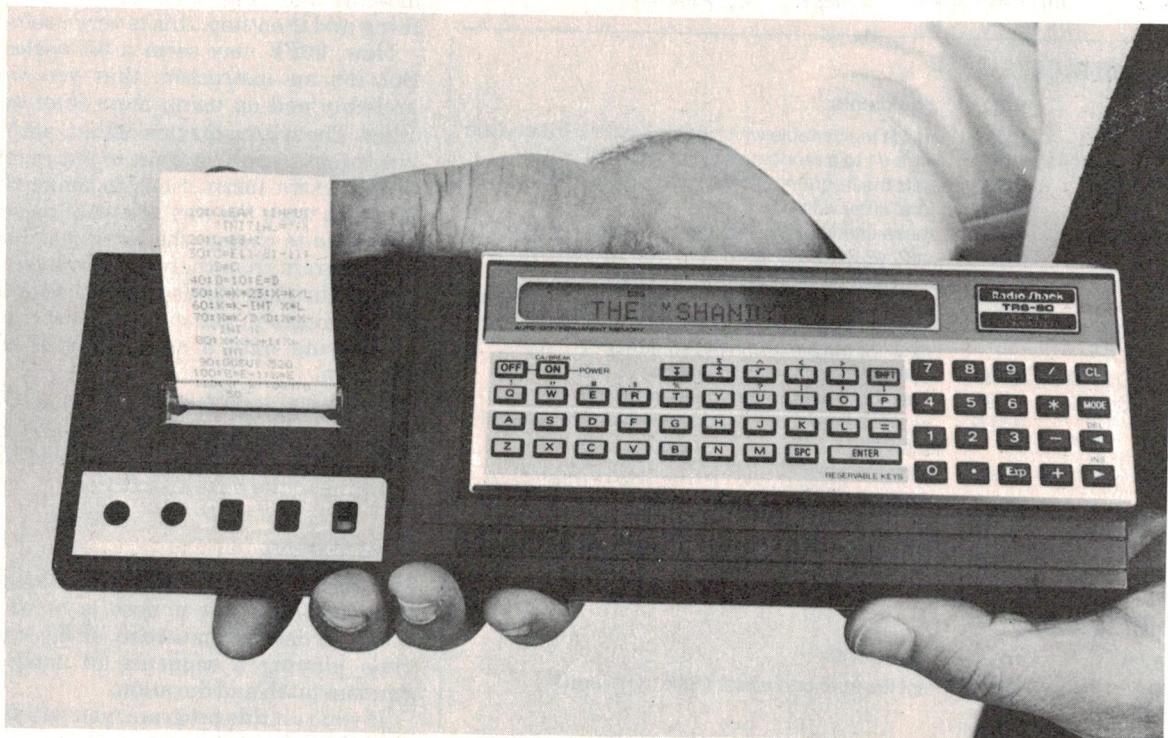
## RANDOM PITCH AND BLOCKS

address	mnemonic	code	comments
0600	V0 = V8	6008	this is the variable which holds the timer initial value
0602	V1 = RND AND FF	C1FF	sets V1 to a random value between 00 and FF
0604	PITCH = V1	F100	sets the frequency of the tone to the random value
0606	TIME = V0	F015	load timer with 08
0608	TONE = V0	F018	make a tone of the same length as the timer period
060A	V2 = TIME	F207	sets V2 to the current timer value so that it can be kept an eye on by the next instruction
060C	SKF V2 = 00	3200	skip the next instruction if the timer has reached 00
060E	GOTO 060A	160A	loop back to wait for the timer if it's not finished yet
0610	VA = RND AND 37	CA37	Now for the blocks on the screen ...
0612	VB = RND AND 37	CB37	sets VA to somewhere between 00 and 37
0614	I = 61A	A61A	sets VB to somewhere between 00 and 37
0616	SHOW 7 @ VA, VB	DAB7	sets I to the end of the program (where there is spare memory)
0618	GOTO 0600	1600	puts the block at I onto the screen at the random position VA, VB
061A ...	0620:		go and do it all again ...
			these locations will hold the 'pattern' that will end up on the screen. (Try filling them with FFs).

## SONG IN THE KEY OF YALE

address	mnemonic	code	comments
0600	I = 0622	A622	set the memory pointer to the 'data' area
0602	V1 = 0F	610F	
0604	V0 = FF	60FF	
0606	V0 = V0 + 01	7001	this will set V0 to 00 the first time through (the result of the addition will be 100, and the first digit will end up in VF).
0608	V0 = V0 AND V1	8012	this makes sure that V0 is between 00 and 0F (if you like, it 'masks' out the left-hand digit).
060A	SKF V0 = KEY	E09E	V0 is busy being the numbers from 00 to 0F one by one — when you press a key, this loop will try all of the possible values until V0 matches the key.
060C	GOTO 0606	1606	loop back and try the next value of V0
060E	V2 = 08	6208	
0610	I = I + V0	F01E	points I at one of the locations between 0622 and 0632, depending on what V0 is (and therefore on what key was pressed)
0612	V0:V0 = M(I)	F065	this loads the value in the memory location pointed to by I into V0
0614	PITCH = V0	F000	... and this is why — each location from 0622 to 0630 holds the pitch which corresponds to that key
0616	TIME = V2	F215	
0618	TONE = V2	F218	set up the timer and the beeper for a beep of length V2 (which is 08).
061A	V2 = TIME	F207	set V2 to keep an eye on the time
061C	SKF V2 = 05	3205	let the timer go until it gets to 5, then look for the next note (if there is none, it will sound for 100 milliseconds after the key is released).
061E	GOTO 061A	161A	keep looking at the timer ...
0620	GOTO 0600	1600	next key
0622	data	8071	these locations hold the required pitch settings for C major — perhaps you can change them to get sharps and flats?
0624		655F	
0626		544B	
0628		433F	
062A		3832	
062C		2F2A	
062E		2521	
0630		1F1C	

# "You'll have a shandy, then?..."



**Tom Moffat**

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Imagine this scenario: a man walks into his local computer shop intending to buy a printer. A few minutes later he's made his selection. The salesman wraps it up and hands it to the buyer, who then carts it down the stairs and out the front door. Strapping the printer parcel to the handlebars of his bike, he heads off home ...

IT'S NOT FICTION; that's exactly how the Sharp CE-122 dot impact printer fell into this writer's hands. This printer would probably qualify as the smallest on the market at the time of writing. It's designed to mate with the Sharp PC-1211 pocket computer, and, unofficially, with the Tandy pocket TRS-80.

A previous article on pocket computers (ETI Jan. 1981) pointed out that although neither Sharp nor Tandy had a printer available for their products,

the computers had the appropriate control lines brought out for printer control. Now Sharp at least has released the printer, and it works equally well with either the Sharp or Tandy computer, which for all practical purposes are the same machines.

It appears that Tandy aren't ready to release a printer for their pocket TRS-80. After several approaches to them they'd only say it was under consideration, and when told that Sharp already had one out that worked very

nicely with the Tandy computer, their only response was "no comment". So for the moment we'll look at the Sharp printer/Tandy computer combination — maybe we should call it the 'Shandy'!

## Printer design

The physical design of the CE-122 is much along the lines of the Sharp/Tandy cassette interface. It forms a cradle into which the computer is inserted, making contact with a plug at the computer's left hand end. The

printer mechanism itself is in an extension to the interface's normal length, adding about 75 mm to the left hand end. Near the back is a compartment which holds a tiny roll of paper (it looks like a small roll of cash register tape). The paper is nothing special and is therefore quite cheap (about 28 cents a roll). Another little cover on top opens to reveal a tiny nylon ribbon in an endless cartridge, said to be good for about 10 000 lines of print.

You can see the printing going on through a little window, and completed copy rolls up through a slot in the top, which has a serrated edge for tearing the paper off.

Below the slot is a row of controls: a LED that flashes when the printer's rechargeable battery is low, a button to advance the paper, a switch to override tape motion control in the cassette interface, a switch to enable the printer, and a power switch for the whole unit.

The cassette interface is much like the one supplied separately, although the one in the printer unit seems to be less sensitive to input level variations than the free-standing interface.

The printer mechanism works in a most unusual way; instead of printing each character in one hit and then advancing to the next one, it prints the top row of dots of a line of characters, then jumps down and does the next line, and then does it again and again until a complete line of 5 x 7 matrix characters is printed.

Information to be printed is supplied by the computer simply as a burst of serial data. The printer has its own CPU, a printing control chip, and a 1K RAM to store the data, convert it to the proper format, and control the action of the print head. In fact the printer seems to have nearly as much electronics in it as the computer itself.

Because it gets the data transfer over quickly, the computer is able to get on with its main task while the printer is sorting out the print data. The computer therefore sometimes asks for new input data on its liquid crystal display while previous computation results are still being printed.

The computer gets into the print mode in a very sneaky way ... and I spent untold hours trying to crack it before the printer came on the market.

## But how?

The usual Tandy 'LPRINT' results in a syntax error; so does APRINT, BPRINT, CPRINT, DPRINT, and every other combination you can think of. The print mode is in fact selected by pressing the break key twice (now whoever would have thought of that!). Knowing how to get the computer to spit the data out, I'd like its serial port to allow one to use another computer to generate print data for a conventional teletype machine (I'm working on it).

In the 'Shandy' system, when the print mode is selected print statements no longer come up on the LCD display; instead they come up on the printer, sixteen characters to a line, and if the

statement is more than sixteen characters long it simply continues on the next line, breaking a word in half if necessary. However, if the programmer formats the print statements with extra spaces to prevent word splitting, the result looks quite presentable.

The list function is done in two different ways. If you type in 'LIST 10' or any list with a line number, the line in question appears on the LCD display in the normal way. But if you type 'LIST' with no line number, the computer will proceed to output every line in its memory to the printer. It uses a special format: first the line number on the left of the paper, then the contents of the line. If the line length runs longer ►

WOULD YOU BELIEVE IT? — This arrived the day we went to press!

## TANDY ELECTRONICS NEWS RELEASE

DATE: 1st October, 1981

RELEASE NO: TC-811001-DH

SUBJECT: Pocket Printer

### FOR FURTHER INFORMATION CONTACT

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### Pocket Printer Now On Sale

Tandy Electronics, manufacturers and retailers of the world's largest-selling little computer - the TRS-80, have released a miniature printer and cassette interface combination to suit the widely-acclaimed TRS-80 Pocket Computer.

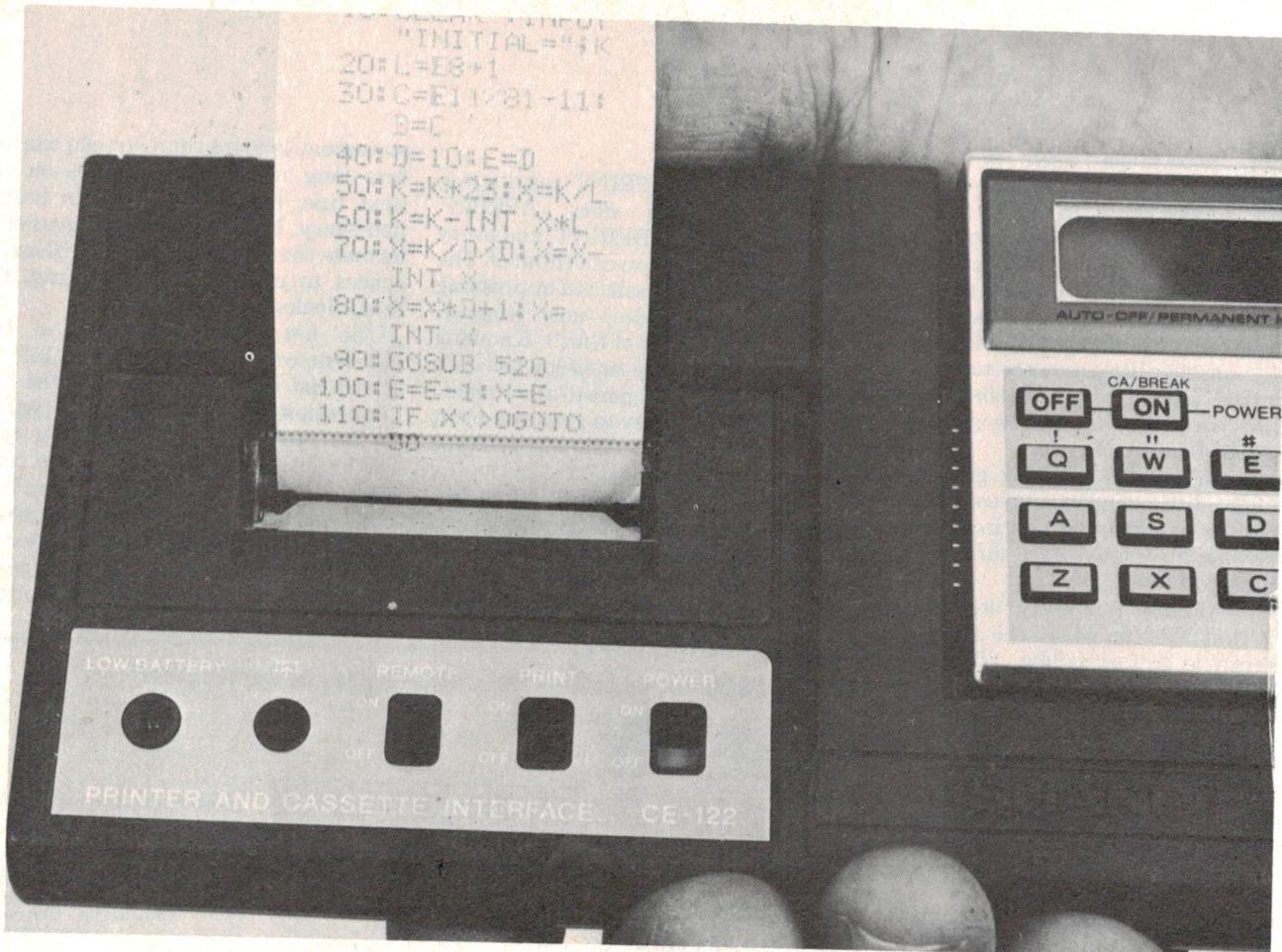
The tiny printer outputs 16 alpha-numeric characters per line, with automatic "wrap-around" of lengthy text to the next line. Data printouts and programme listings are printed in easy-to-read dot matrix characters.

The built-in cassette interface allows programmes and data to be dumped to and loaded from cassette tape with a suitable recorder, such as the Minisette-9 Ultra Slim Cassette Recorder (Cat No. 14-812, \$89.95).

The Printer/Cassette Interface (Cat. No. 269-3505) retails for \$149.95 complete with rechargeable batteries and a mains adaptor/charging unit. Also included is a ribbon cartridge, three rolls of paper, cassette cable and manual.

The TRS-80 Pocket Computer, Printer/Interface and Minisette Cassette Recorder combine to make a useful tool for architects, engineers, accountants or salesmen who need a small system to fit in a briefcase or handbag. The Pocket Computer can handle many of the tasks carried out on desktop-sized microcomputers, and its' versatility is further enhanced by hard-copy printout and cassette data and programme storage.

These products are available from and Tandy TRS-80 Computer Centre or through any of nearly 300 Tandy Stores and Dealers throughout Australia.



than 16 characters, printing continues on the next line; four spaces are first added to line numbers so they appear in one column, and line contents stay in their own column. This makes for a very

#### SPECIFICATIONS: SHARP CE-122 PRINTER.

Columns: 16  
Dot structure: 5 x 7 matrix  
Print speed: approx. one line per second  
Battery life: about 8000 lines per charge  
Recharging time: about 15 hours  
Power consumption: 1.84 watts

neat and easy to read list.

Any program written for the computer in the normal way will work with the printer, with PRINT statements being printed and PAUSE statements appearing on the LCD display. But rewriting a program to take advantage of the printer's format makes for a much nicer result.

To demonstrate this we've included two versions of a spacecraft landing program, originally translated from the one included with Tandy's TRS-80 Level 2 BASIC manual. The first

version is designed for the pocket computer only, without a printer; the second has had a few changes made to take full advantage of the printer. The program gives a choice of four bodies to attempt a landing on, with gravity effects appropriately modified for each.

It also takes into account the reducing weight of the spacecraft as fuel is consumed. The 'fuel' burn is entered as a percentage of maximum thrust, from 0 to 100, and the result of the landing is displayed with the appropriate comments. Have fun!

#### PRINTER VERSION

```

5:CLEAR
10:PRINT " ";
PRINT "SPACE
SHIP LANDER"
20:PAUSE "ENTER
DESTINATION
"
30:INPUT "EARTH
,MOON,MARS,V
230:Q=Q-JH:W=G
240:I=L+LP/-2E-J
0/(C+0)
250:G=F+IH:R=P
260:P=P+(G+F)/A*
H:F=G
270:IF P<0THEN 30

```

#### LCD DISPLAY VERSION

```

5:CLEAR
10:PAUSE "*** S
PACESHIP LAN
DER ***"
20:PAUSE "ENTER
DESTINATION
"
OLET H=T
230:Q=Q-JH:W=G
240:I=L+LP/-2E-J
0/(C+0)
250:G=F+IH:R=P
260:P=P+(G+F)/A*
H:F=G

```

```

ESTA:",S$  

32:PRINT "* DES  

    TINATION *"  

34:PRINT " > >  

    ";S$;"! < <"  

40:IF S$=="EARTH  

    "LET K=980.7  

    :E=6371:GOTO  

    90  

50:IF S$=="MOON"  

    LET K=162:E=  

    1738:GOTO 90  

60:IF S$=="MARS"  

    LET K=374:E=  

    3380:GOTO 90  

70:IF S$=="VESTA  

    "LET K=17.5:  

    E=195:GOTO 9  

    0  

80:PAUSE "NAV.  

    ERROR--TRY A  

    GAIN":GOTO 3  

    0  

90:PRINT " GRAY  

    ITY":;USING  

    "####.#";K  

92:PRINT " ":"  

    PRINT " HGT  

    VEL FUEL"  

100:L=K/36:M=INT  

    (JL*E2)  

110:IF M<175LET  

    M=175  

120:N=INT (55M)  

130:IF N>4LET N  

    =E4  

140:D=N*LN K/20+  

    E4  

150:A=-6.4E3:B=5  

    E3:C=1.5E4:D  

    =E1  

160:H=D:F=B:P=M:  

    Q=N  

170:PRINT USING  

    "####";P;  

    USING "#####"  

    ;F;USING "#  

    #####";Q:  

    GOTO 190  

180:PRINT USING  

    "##.##";P;  

    USING "##.##.  

    ##";F;USING "  

    #####";Q  

190:INPUT "ENTER  

    PERCENT POW  

    ER:";J  

195:USING :PRINT  

    " BURN=";J  

200:IF J=0THEN 2  

    30  

210:IF (J<0)+(J)>  

    100)THEN 310  

220:T=Q/J:IF T<1  

    OLET H=T

```

```

280:IF Q<=0THEN  

    320  

290:IF (P<10)*(F  

    <E3)THEN 180  

300:GOTO 170  

310:PAUSE "ILLEG  

    AL BURN, USE  

    0-100":GOTO  

    190  

320:X=J(FF+5650P  

    L):PRINT "OU  

    T OF FUEL!":  

    GOTO 340  

330:X=J(ABS (R/2  

    61))*I+W  

340:BEEP 1:PRINT  

    "YOU HAVE...  

    "  

350:IF X<20PRINT  

    "LANDED OK."  

    :GOTO 400  

360:IF X<100  

    PRINT "CRASH  

    EI.":GOTO 42  

    0  

370:IF X<250  

    PRINT "BEEN  

    BLOWN UP.":  

    GOTO 450  

380:IF X<5000  

    PRINT "MADE  

    NEW CRATER."  

    :GOTO 450  

390:IF X>4999  

    PRINT "BEEN  

    VAPOORIZED.":  

    PRINT "*** B  

    OOM!!! ***"  

400:IF X<1PRINT  

    "NICE TOUCH-  

    ";:PRINT "VER  

    Y GOOD!":  

    GOTO 450  

410:IF X<5PRINT  

    "A BIT ROUGH  

    ...":GOTO 45  

    0  

420:IF X<30PRINT  

    "UNABLE TAKE  

    OFF.":GOTO  

    450  

430:IF X<45PRINT  

    "LANDER ON F  

    IRE.":GOTO 4  

    50  

440:PRINT "THERE  

    ARE":PRINT  

    "NO SURVIVOR  

    S."  

450:PRINT "IMPAC  

    T VELOCITY=":  

    PRINT USING  

    "#####.##";X  

460:USING :GOTO  

    10

```

```

30:INPUT "EARTH  

    ,MOON,MARS,V  

    ESTA:",S$  

40:IF S$=="EARTH  

    "LET K=980.7  

    :E=6371:GOTO  

    90  

50:IF S$=="MOON"  

    LET K=162:E=  

    1738:GOTO 90  

60:IF S$=="MARS"  

    LET K=374:E=  

    3380:GOTO 90  

70:IF S$=="VESTA  

    "LET K=17.5:  

    E=195:GOTO 9  

    0  

80:PAUSE "NAV.  

    ERROR--TRY A  

    GAIN":GOTO 3  

    0  

90:PAUSE S$;" G  

    RAVITY=";  

    USING "####.  

    #";K  

100:L=K/36:M=INT  

    (JL*E2)  

110:IF M<175LET  

    M=175  

120:N=INT (55M)  

130:IF N>4LET N  

    =E4  

140:D=N*LN K/20+  

    E4  

150:A=-6.4E3:B=5  

    E3:C=1.5E4:D  

    =E1  

160:H=D:F=B:P=M:  

    Q=N  

170:PRINT "H":  

    USING "####.  

    #";P;" V";  

    USING "####"  

    ;F;" F";  

    USING "####"  

    #";Q:GOTO 19  

    0  

180:PRINT "H":  

    USING "##.##  

    #";P;" V";  

    USING "####.  

    #";F;" F";  

    USING "####"  

    #";Q  

190:INPUT "ENTER  

    PERCENT POW  

    ER:";J  

200:IF J=0THEN 2  

    30  

210:IF (J<0)+(J)>  

    100)THEN 310  

220:T=Q/J:IF T<1

```

```

    OLET H=T  

270:IF P<0THEN 3  

    30  

280:IF Q<=0THEN  

    320  

290:IF (P<10)*(F  

    <E3)THEN 180  

300:GOTO 170  

310:PAUSE "ILLEG  

    AL BURN, USE  

    0-100":GOTO  

    190  

320:X=J(FF+5650P  

    L):PAUSE "OU  

    T OF FUEL!":  

    GOTO 340  

330:X=J(ABS (R/2  

    61))*I+W  

340:BEEP 1:PAUSE  

    "YOU HAVE...  

    "  

350:IF X<20PAUSE  

    "LANDED OK."  

    :GOTO 400  

360:IF X<100  

    PAUSE "CRASH  

    EI.":GOTO 42  

    0  

370:IF X<250  

    PAUSE "BEEN  

    OBLITERATED.  

    ":"GOTO 450  

380:IF X<5000  

    PAUSE "MADE  

    A NEW CRATER  

    .":GOTO 450  

390:IF X>4999  

    PAUSE "BEEN  

    VAPOORIZED.**  

    BOOM!!!":  

    GOTO 450  

400:IF X<1PAUSE  

    "NICE TOUCH-  

    -VERY GOOD!":  

    :GOTO 450  

410:IF X<5PAUSE  

    "A BIT ROUGH  

    ...":GOTO 45  

    0  

420:IF X<30PAUSE  

    "UNABLE TO T  

    AKE OFF.":  

    GOTO 450  

430:IF X<45PAUSE  

    "LANDER IS O  

    N FIRE.":  

    GOTO 450  

440:PAUSE "THERE  

    ARE NO SURV  

    IVORS."  

450:PRINT "IMPAC  

    T VELOCITY=":  

    USING "####.  

    #";X  

460:USING :GOTO  

    10

```

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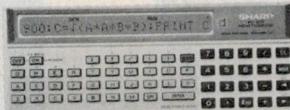


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# PET talk — memory test

MEMORY TEST is a simple program for PET owners, or those with other micros that support sound boxes. The game is a version of the 'Simon' toy in that you have to remember an increasing sequence of numbers and their associated tones.

All the instructions are included in the program and the characters within square brackets are to the usual CT standards. Connections to a soundbox are from the N and M pins on the user port. A simple amplifier will suffice.

## Program listing

```

1 REM**MEMORY TEST
4 CLR
5 PRINT" [CLS ]MEMORY TEST"
6 S1=59464:S2=59466:S3=59467
8 PRINT" ====="
10 PRINT"THE IDEA OF THIS GAME IS TO
REPRODUCE"
20 PRINT"THE SERIES OF NUMBERS I WILL
PRINT FOR"
30 PRINT"YOU."
40 PRINT"IF YOU MAKE A MISTAKE PRESS
'HOME' & TRY"
45 PRINT"AGAIN, OR PRESS 'DEL' TO DELETE
LAST GO."
50 PRINT"PRESS 'E' TO END."
60 PRINT"DO YOU REQUIRE SOUND? (Y/N) ";
61 GET A$
62 NU=RND(TI):REM**RANDOMISE
63 IF A$ = " " THEN 61
70 IF A$ = "N" THEN POKE S3,0:GOTO 77
75 IF A$ = "Y" THEN POKE S3,16:GOTO 77
76 GOTO 61
77 PRINT A$
78 INPUT"RATE OF CHANGE OF SEQUENCE
LENGTH":R
80 INPUT"MAXIMUM SEQUENCE LENGTH?":S
83 IF S > 80 THEN S = R - 1:REM ** 80 IS MAX FOR
8K PET
85 IF S < R THEN PRINT"ERROR, SEQUENCE
LENGTH";R;"TO 80";:INPUT S:GOTO 83
94 PRINT"GOOD LUCK!":FOR Q = 1 TO 700:NEXT
95 REM**PICK SEQUENCE & STORE
99 DIM N(S + 2),M(S + 2)
100 FOR A = 1 TO S
150 N(A)=INT(10*RND(TI))
200 NEXT
300 G=0
350 REM**MAIN PRINTING ROUTINE
400 G=G+R
410 IF G > S THEN G=S
450 PRINT" [CLS ][8 CD ]";
500 FOR A = 1 TO G
530 POKE S2,15:POKE S1,150-N(A)*10
550 PRINT N(A)" ";
555 FOR X = 1 TO 100:NEXT:POKE S1,0
560 IF A/10 = INT(A/10)THEN PRINT" ";
600 NEXT
650 PRINT" [HOM ]YOU HAVE ";INT(G/2);"
SECONDS TO MEMORISE THE SEQUENCE";
651 PRINT" . . . . .";G;"NUMBERS"
700 FOR Q = 1 TO 450*G:NEXT
730 REM**YOUR REPLY
740 POKE S1,70:FOR P = 1 TO 100:NEXT:POKE S1,0
750 PRINT" [CLS ]O.K. NOW RETYPE THE
SEQUENCE"
753 FOR K = 1 TO 10:GET W$:NEXT
755 REM**SOAK UP EXTRA KEY PRESSES
780 PRINT" [HOM ][8 CD ]":FOR C = 1 TO G:
PRINT" [↑$ ]";:IF C/10 = INT(C/10) THEN
PRINT" ";
790 NEXT
795 PRINT" [HOM ][8 CD ]";
800 FOR A = 1 TO G
810 FOR U = 1 TO 100:NEXT
830 POKE S1,0
850 GET A$:IF A$ = " " THEN 850
855 B=VAL(A$)
860 IF A$ = "[HOM ]" THEN PRINT" [CLS ]TRY
AGAIN":POKE S1,0:FOR K = 1 TO 1000:NEXT:
GOTO 750
862 POKE S2,15:POKE S1,150 - 10*B
863 IF A < = 2 THEN GOTO 868
865 IF A$ = CHR$(20) THEN A = A - 1:PRINT" [3 CL ]
[↑$ ] [2 CL ]";
867 IF A$ = CHR$(20) AND (A - 1)/10 = INT
((A - 1)/10) THEN PRINT" [CU ]";
868 IF A$ = CHR$(20) THEN 810
869 IF A$ = "E" THEN POKE 59467,0:END
873 PRINT B;" ";
875 REM**PRINT IN ROWS OF TEN
876 IF A = 0 THEN 880
877 IF A/10 = INT(A/10) THEN PRINT" [CD ]";
880 M(A)=B
900 NEXT A
910 POKE S1,0
950 REM**CHECK FOR ERRORS
999 ER = 0
1000 FOR A = 1 TO G
1010 IF N(A) < > M(A) THEN ER = ER + 1
1050 NEXT
1100 IF ER > 0 THEN GOTO 1500
1130 IF S > G THEN GOTO 1150
1140 GOTO 5000
1145 REM**CORRECT REPLY
1150 PRINT" [CLS ]CORRECT TRY A LONGER
SEQUENCE"
1155 REM**TONE FOR CORRECT REPLY
1156 POKE S2,15:POKE S1,50:FOR Z = 1 TO 20:POKE
S1,50
1160 FOR X = 1 TO 80:NEXT:POKE S1,100:NEXT:
POKE S1,0:GOTO 400
1460 REM**INCORRECT REPLY
1500 PRINT" [CLS ]WRONG, YOU MADE";ER;
"MISTAKES, TRY AGAIN"
1520 REM**TONE FOR INCORRECT REPLY
1530 POKE S2,15:POKE S1,200:FOR Q = 1 TO 12:
POKE 59464,230
1550 FOR U = 1 TO 35:NEXT:POKE 59464,180:NEXT:
G = G - R:GOTO 400
2000 T = TI:IF TI = T + 60*G THEN NEXT
4200 REM**TOTAL SEQUENCE
5000 PRINT" [CLS ][7 CD ] FANTASTIC!"
5010 PRINT" YOU MADE YOUR SEQUENCE OF";
INT(S);";NUMBERS"
5050 FOR H = 1 TO 7
5060 FOR J = 200 TO 10 STEP - 10
5080 POKE S1,J/2
5100 NEXT:NEXT
5150 REM**POKE 59467,0 TO REACTIVATE
CASSETTE
5200 POKE 59464,0
5500 PRINT"ANOTHER GAME?";
5510 GET A$:IF A$ = " " THEN 5510
5515 PRINT AS
5520 IF A$ = "Y" THEN 1
5530 IF A$ = "N" THEN POKE 59467,0:END
5555 GOTO 5500
63999 END

```

K. Townsend





# In the world of personal computers there is just one that is known as the best: the PET

The Commodore PET has become the standard for the Personal Computer Industry.

The Pet is completely integrated, with the processor, memory, keyboard and visual display unit contained within a robust housing, allowing easy transportation with no interconnecting cables necessary. In order to retrieve and save your data and programs, a storage device is used which operates like a cassette recorder, with your information recorded reliably on standard cassettes. The PET has 16k bytes of RAM. Optional equipment permits expansion to 32k. Also, it has 14k bytes of ROM.

The Pet communicates in BASIC—the easiest computer language. Easy to learn and easy to use, BASIC has now become the standard for personal computers, with literally thousands of programmes available. The PET is also programmable in machine language, allowing more efficient use of the system.

The full-size keyboard is capable of producing letters, numbers and graphic symbols. Upper and lower case is standard. Characters appear

on the screen in a pleasant green colour designed to reduce eye fatigue and may be displayed in normal or reverse print.

PET's IEEE-488 Bus—just like H.P.'s mini and full size computers—permits direct connection to over 200 pieces of compatible equipment such as counters, timers, spectrum analysers, digital voltmeters and printer plotters from H.P., Philips, Fluke, Textronix and others.

The full range of Commodore Disk Drives and Printers are plug-compatible with the PET and a comprehensive range of cassette and disk based programmes are available through the extensive network of Commodore Dealers.

## APPLICATIONS

The Commodore PET is a creature of many faces. Its applications are limited only by the user's imagination.

The future of the PET is virtually unlimited; its present capabilities are already many and impressive. As a personal computer, the PET can teach languages and mathematics; play games; create graphic designs; store meal recipes and change

number of portions; maintain budgets, personal records and checkbooks; operate appliances and temperature controls.

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And the businessman has a computer that can maintain inventories, keep payroll records, operate accounts payable and receivables, issue cheques and handle correspondence.

## Commodore PET 4016 Computer Technical Specifications.

### Computer/Memory

Read/Write Memory (RAM) 16K bytes available to the user.

Read Only Memory (ROM) 14K bytes in total, divided into:

8K BASIC interpreter available immediately you turn on your PET,

5K Operating System

1K Test Routine

The 6502 micro-processor chip makes the PET one of the fastest and most flexible BASIC systems. Significant features of Commodore BASIC are:

- 960 simple variables
- 960 integers
- 960 string variables
- 960 multi-dimensional array fields for the above 3 types of variables
- Up to 80 characters per program line with several statements per line
- Upper/Lower case characters and graphics capability
- Built in clock
- 9-digit floating point binary arithmetic
- True random number generator
- Supports multiple languages; machine language accessibility

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74-Key professional keyboard. Separate calculator/numeric pad.

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23 cm screen phosphor screen.

Brightness control.

64 ASCII plus 64 graphics characters.

Blinking cursor with full cursor control, including programmable control.

### Screen editing capabilities

Full cursor control (up, down, left, right).

Character insert and delete.

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Return key sends the entire line to the CPU regardless of cursor position.

### Input/Output

8 bit parallel input/output port. IEEE-488 Bus (HP-IB and IEC Bus) allows up to 12 other peripherals to be connected.

Two cassette ports.

Video signals for additional displays.

Serial output port.

### Technical Data

Dimensions: Height 355 mm (14"), Width 419 mm (16.5"), Depth 185 mm (18.5"). Shipping Weight 20.9 kg (46 lbs).

Power requirements 240V ± 10%, Frequency 50 Hz, Power 100 Watts.

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## Commodore BASIC

APPEND	GOSUB..RETURN STOP	SPC
BACKUP	IF..THEN	SYS LEFT\$
CLOSE	INPUT	VERIFY RIGHTS\$
CLR	INPUT *	WAIT MID\$
CMD	LET	CHR\$
COLLECT	LIST	SGN ASC
CONCAT	LOAD	INT LEN
CONT	NEW	ABS VAL
COPY	ON..GOSUB	SQR STR\$
DATA	OPEN	SIN TI
	POKE	COS TI\$
DEF/FN	PRWT	TAN ST
DIM	READ	ATN DS
DIRECTORY	RECORD	LOG DS\$
DLOAD	REM	EXP +
DOPEN	RENAME	AND -
DSAVE	RESTORE	OR *
END	RUN	NOT /
FOR/NEXT	SAVE	TAB ↑
GET	SCRATCH	POS π

# commodore

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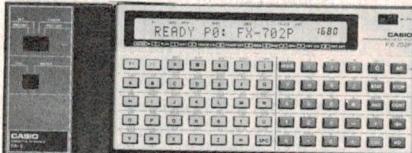
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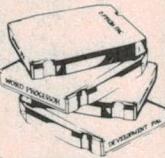
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# ADVANCED BASIC

## Part 4

### Interpreters, compilers and assemblers

Phil Cohen

Following its series on Back Door into BASIC, ETI has begun a series on Advanced BASIC for those who want to expand their knowledge further. Phil Cohen has already examined 'Sorting', 'Chaining' and 'Top-down programming' in earlier parts of the series, and this month his subject is 'Interpreters, compilers and assemblers'.

A FEW MONTHS ago I attended a meeting of an amateur computer society (which shall remain nameless) and heard the speaker (who shall also remain nameless) asked the question, "What's the difference between an interpreter and a compiler?". He thought for a few moments and then said, "Well, a compiler is non-interactive, isn't it?" (i.e. you can't enter data while the program is running).

This is of course totally wrong. The reason *why* it's wrong is, however, interesting. Compilers just aren't found in home systems yet. The reason for this is that they tend to need more RAM and are more difficult to design than interpreters. Thus they are usually found in mainframe systems only. Why, if they're so much trouble, should professional programmers use them? The answer is that they are extremely powerful — their advantages are well worth the extra RAM.

In order to describe what exactly a compiler (and, while we're at it, an assembler) is, we have to define a few terms:

**SOURCE CODE:** The program in BASIC (or whatever) as it is typed in, spaces and all.

**OP CODES:** Or 'operator codes' — a set of numbers (usually one byte each) which represent BASIC keywords. In the Commodore PET, the source code is translated into op codes as it is fed in (try putting graphics characters in a REM statement).

**MACHINE CODE:** Well, anyone who started reading this article should know what this is, but just in case — it's a set of numbers, each of which represents an instruction to the processor itself.

**ASSEMBLY CODE:** A set of mnemonics (usually three or four characters each) which are easier to remember than machine code, but mean the same — there is a 'one-to-one correspondence' between machine code and assembly code.

**INTERMEDIATE CODE:** Or, in the case of PASCAL, 'P-code'. This is a set of instructions to an imaginary processor. This is more useful than it sounds, as will be explained later.

**INTERPRETER:** A program which pretends to be a processor which will accept source code or op codes as instructions.

**ASSEMBLER:** A program which translates assembly code into machine code.

**COMPILER:** A program which translates source code into machine code. Some compilers translate source code into intermediate code, which is then run on an interpreter which pretends to be the intermediate code's processor. This is a compromise between a compiler and an interpreter.

**EDITOR:** A program which allows source code or assembly code to be input, changed, listed and generally messed about.

**ASSEMBLER/EDITOR:** A package containing one of each.

#### Assemblers

What is required of an assembler? While on the one hand some very primitive ones just take in one assembly code mnemonic at a time and output one (or more) bytes of machine code, most assemblers do a lot more. Let's take the example of the following program segment:

ADDRESS	
1	LDA 8
3	DEC
4	JNZ 3

The address is the position in RAM of the first byte of each instruction. LDA causes the next byte of code to be loaded into the accumulator. As the assembler knows that this is a two-byte instruction, it will look for a parameter for LDA — in this case 8. DEC decrements the accumulator. JNZ jumps to byte 3 if the accumulator is not zero. Fine. What if we want to change it to:

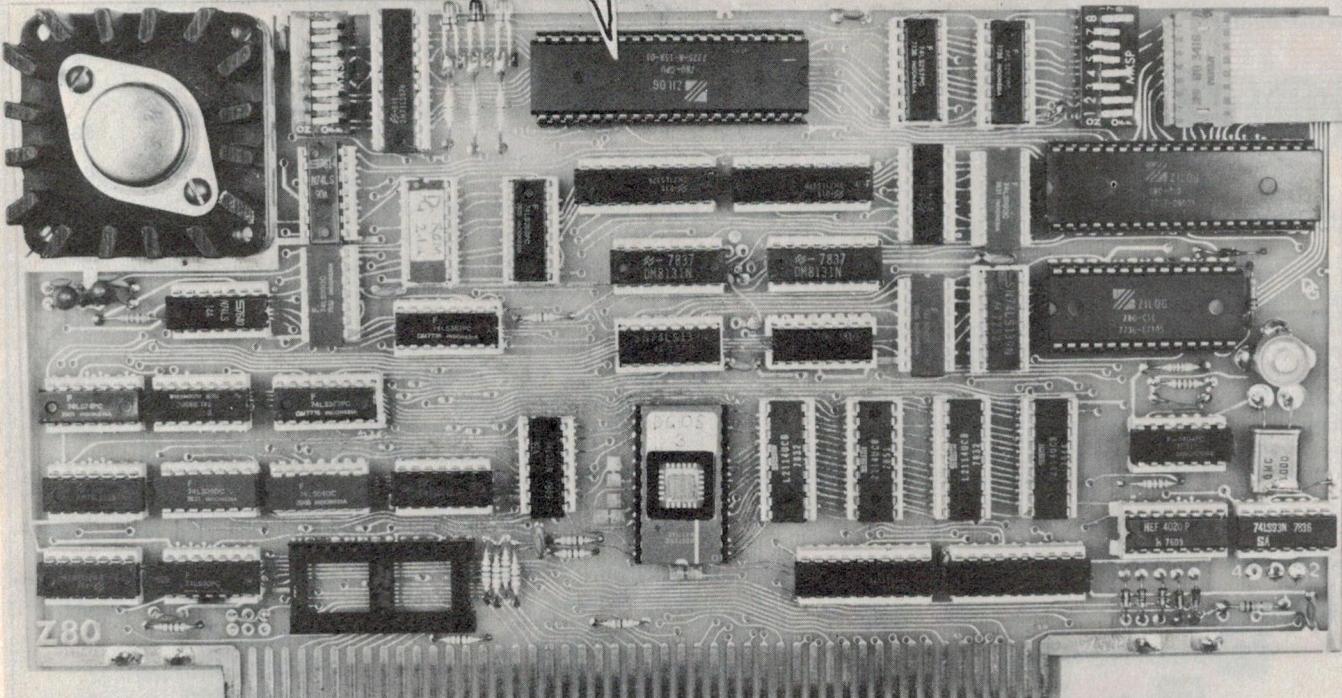
IN 1
INC
JNZ
DEC

In other words, input the accumulator value from port 1, add 1 to it, then loop as before.

How do we know the parameter to use for JNZ? — in a long program we won't know the address of DEC until it is assembled. We can get the assembler to save us the trouble of sorting this out by hand by adding a 'label' facility:

IN 1
INC

I was a 4K weakling  
till I took Dr Digital's  
64K dynamic RAM course!



A: DEC  
JNZ A

The assembler will remember the address of point A and use it as the parameter of JNZ.

What if we want to write:

IN 1

INC

A: JNZ B

DEC

JMP A

RTS

One of the labels points further down the program. At point A the assembler won't know what the address of point B is. A decent assembler will solve this by using a 'multi-pass' technique. That is, it will go through the program more than once. The first time it will find the addresses of all the labels and the second time it will actually produce the machine code. Between passes it will store the label values in a 'symbol table', which will hold the label names and values. This table is very useful for debugging and may be printed out.

Another facility is the use of variable names. These will refer to areas of RAM which can be referred to by name rather than by location. These too will go into the symbol table.

Other facilities may include comment statements (like REMs) and other debugging aids.

# Compilers

In many ways compilers are very much like assemblers — the major difference being the source code. Compilers also produce symbol tables.

Trying to design a compiler is probably the best way to get to know how they work. There are a lot of problems which only appear while actually trying to design one. In an earlier article I said that entire books had been written about sorting algorithms. Well, *libraries* have been written about compilers!

The power of a compiler, as opposed to an interpreter, is due to three things:

- a) The compiler checks *every* line of a program as it compiles it — there's no chance of a syntax error appearing while the program is running.
  - b) The machine code output runs about ten times faster than an interpreter.
  - c) It is easier to provide a 'structure' to the language — some compiled languages (e.g: ALGOL 68) do not need GOTO-like statements because the language is constructed to make it possible to do almost anything in a loop structure. For example, the BASIC statements:

```
10 FOR I = 1 TO 10  
20 IF A(I) = B THEN 40  
30 NEXT I
```

could be done in an ALGOL-like language simply as:

10 FOR I TO 10 WHILE A(I) > B DO  
20 NEXT I

I personally think that the sooner small compilers become available the better, especially for highly structured languages such as PASCAL or PL/I. Writing in BASIC implies the use of GOTO statements; some people would hold that this leads inevitably to 'bad habits' in program writing. Certainly, having programmed in both ALGOL and BASIC, I very much prefer the former. The recent rises in personal computing power *should* mean that structured-language compilers will soon be available — I only hope that BASIC is not too firmly embedded in the market to be removed quickly and painlessly.

The following program could form part of an interpreter or compiler. Basically what it does is to sort out bracketed statements in terms of precedence of execution. The program is 're-entrant'. This means that it uses *itself* as a subroutine. Say we have a program segment to strip leading spaces off a string. One way to structure it would be:

```
10 REM REMOVE SPACES  
20 A$ = RIGHT$(A$, LEN(A$) - 1)  
30 IF LEFT$(A$, 1) = " " THEN ►
```

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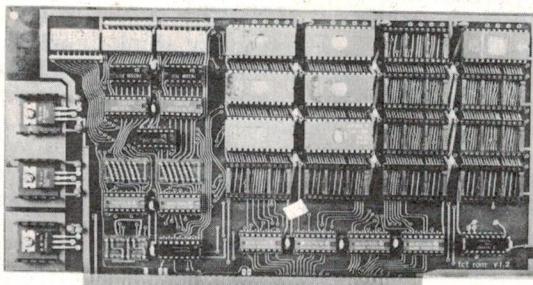
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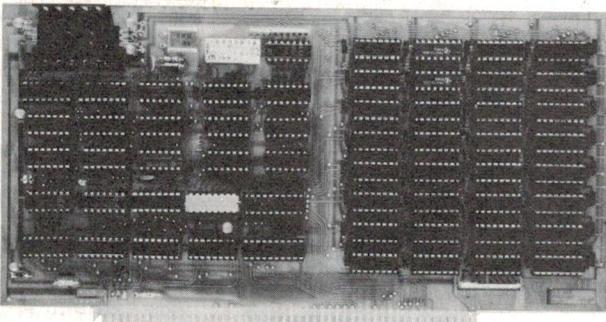
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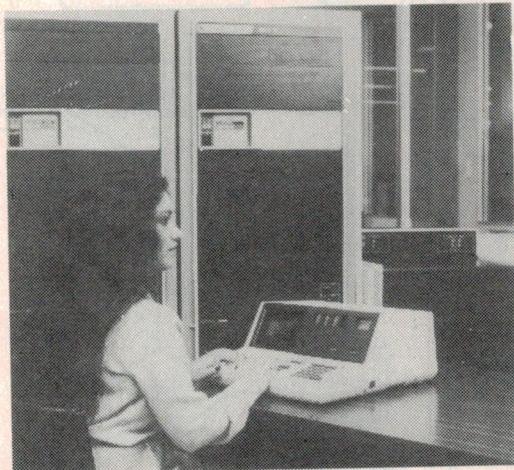
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GOSUB 10  
40 RETURN

Line 30 causes the routine to be re-entered unless there are no spaces left. While the above task *could* be done using a simple loop, the task of analysing a bracketed expression is such that intermediate results have to be stored in a particular order. The easiest way of doing this is to use a re-entrancy with a stack structure to hold the intermediate results. As the RETURN address of each GOSUB in a program is held in a stack also, there will be a correspondence between the two. The easiest way to understand this is to follow the program's action.

Given an input of, say, A(B)C, it will output the lowest priority part of the expression first and remove it from the input string. It will then re-enter with the remaining string:

input: A(B)C  
output: CAB

input: A((B)C(D(E)))  
output: A C B D E

First, the main program:

100 DIM S\$(30)

S\$ is the stack.

110 SB = 0 : SE = 30

SB marks the top of the stack, SE is the maximum stack height.

120 INPUT I\$

I\$ is the expression to be analysed.

130 GOSUB 1000 : REM ANALYSE

140 GOTO 120

Now for the analysis routine.

1000 REM ANALYSE

1010 IF I\$ = "" THEN RETURN

checks for null input string — finished.

1030 J = 0

J is the current bracket depth.

1035 I = LEN(I\$) + 1

1040 I = I - 1

This is part of a loop in which I goes from LEN(I\$) to 1. This form (initialising I to the value above its starting value) allows the decrement of I to be at the start of the loop.

1045 IF I < 1 THEN 1080

end of loop check.

1047 IF J < 0 THEN STOP

negative J means too many "("s — an error.

1050 T\$ = MID\$(I\$, I, 1)

T\$ is a temporary store to speed the program up — saves working out MID\$() every time.

1055 IF T\$ = ")" THEN J = J + 1 :  
GOTO 1040

1056 IF T\$ = "(" THEN J = J - 1 :  
GOTO 1040

adjust J to be equal to the bracket depth.  
If T\$ gets past 1055 and 1056 it must be a character for output — but only if it's outside the outer set of brackets.

1057 IF J > 0 THEN 1040

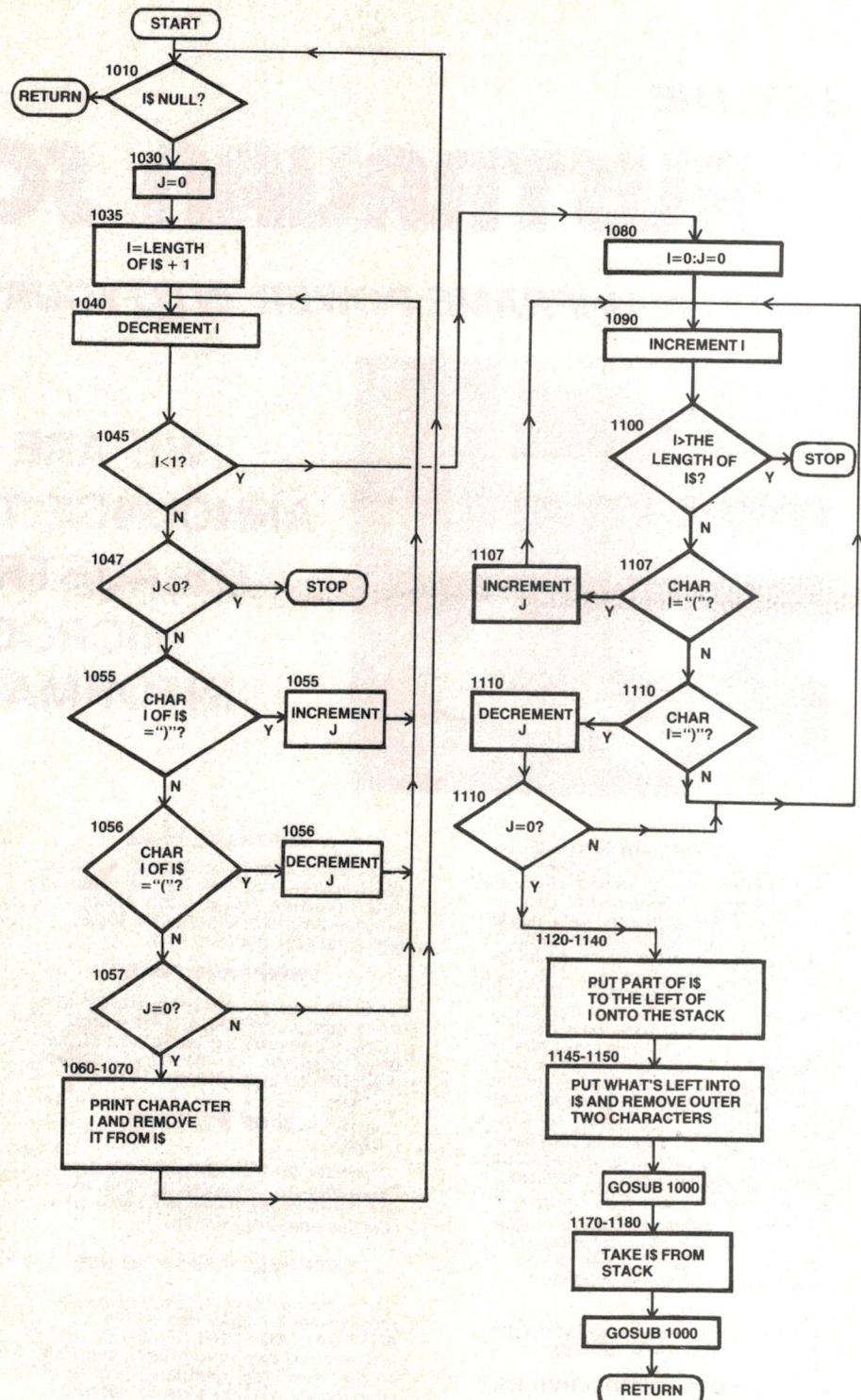


Figure 1. Flowchart for a 'synthetic analyser' — a program to deal with bracketed expressions for a compiler. The input string is I\$.

Okay, T\$ must be valid output if it gets to here.

1060 PRINT " "; T\$; "

The " "s are to show T\$ clearly even if it's a space. Now we have to remove T\$ from I\$:

1061 IF LEN(I\$)=1 THEN I\$= "" : GOTO 1070

1062 IF I=1 THEN I\$=RIGHT\$(I\$, LEN(I\$)-1) : GOTO 1070

1063 IF I=LEN(I\$) THEN

I\$=LEFT\$(I\$, LEN(I\$)-1):  
GOTO 1070

1065 I\$ = LEFT\$(I\$, I-1) +  
RIGHT\$(I\$ LEN(I\$) - 1)

Lines 1061, 1062 and 1063 are necessary because some forms of BASIC (including, unfortunately, the one I'm working in) won't accept LEFT\$(I\$,0) or RIGHT\$(I\$,0).

1070 GOTO 1000

deals with the next character. Line 1045

(the end of the loop) points to:

1080 I = 0 : J = 0

I again points to a specific character in the string and J is again the bracket depth. This part of the program splits the string into a complete bracket pair and another part. It re-enters with both of them.

1090 I = I + 1

1100 IF I > LEN(I\$) THEN STOP

Line 1100 stops the program if a string which got to line 1080 didn't have a bracket pair in it.

1105 T\$ = MID\$(I\$, I, 1)

1107 IF T\$ = "(" THEN J = J + 1 :  
GOTO 1090

1110 IF T\$ = ")" THEN J = J - 1 : IF  
J = 0 THEN 1120

if I points to the end of a bracketed expression, go to line 1120, otherwise:

1115 GOTO 1090

to try the next character.

1120 SB = SB + 1

1130 IF SB > SE THEN STOP

increments the stack pointer and checks for stack overflow.

1135 IF I = LEN(I\$) THEN S\$(SB) =  
" " : GOTO 1145

1140 S\$(SB) = RIGHT\$(I\$, LEN(I\$)  
- I)

1145 I\$ = LEFT\$(I\$, I)

splits I\$ at character I. The value of I



marks the end of a complete bracket pair. Line 1135 serves the same purpose as line 1061 to 1063.

1150 I\$ = MID\$(I\$, 2, LEN(I\$) - 2)  
removes the outer two characters  
(which should be "(" and ")").

1160 GOSUB 1000

re-enters. This will (eventually) reduce I\$ to " ".

1170 I\$ = S\$(SB)

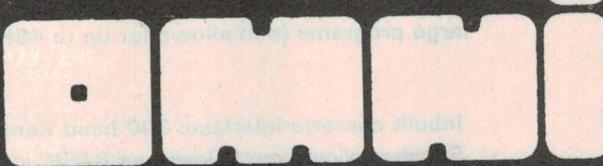
1180 SB = SB - 1  
takes the rest of I\$ back off the stack.

1190 GOSUB 1000  
re-enters with it.

1200 RETURN

finished. Jumps back to wherever it was called from, be it within the subroutine or (when finished) from line 140.

(This article concludes Phil Cohen's 'Advanced Basic' series.)



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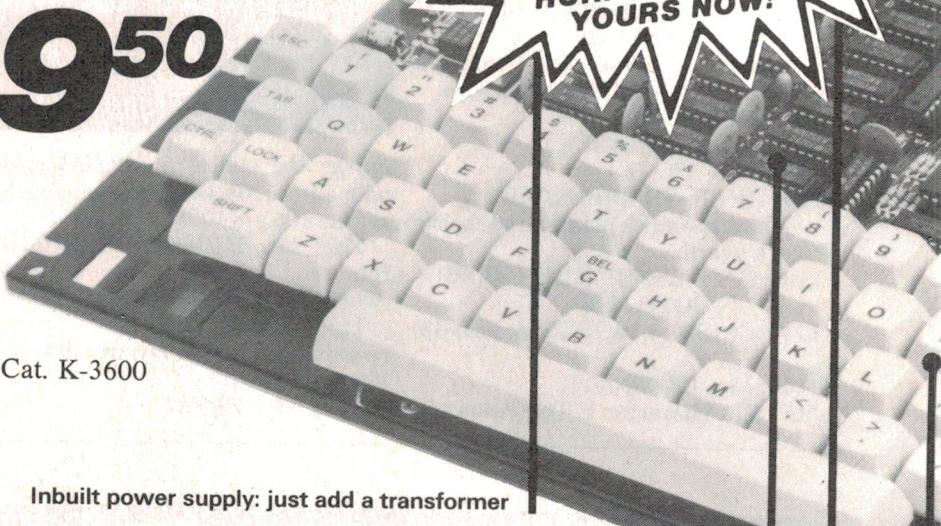
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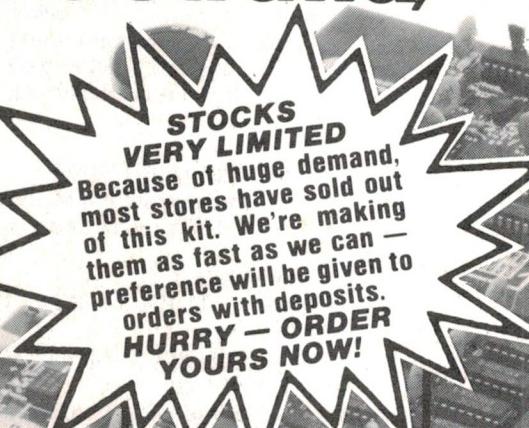
This is not a half baked design with no back up. The resources of Electronics Australia, Australia's most popular electronics magazine, and Dick Smith Electronics have combined to design and bring you this kit in the interests of computer enthusiasts actually building and not just buying. The design is fully Australian.

### **Imagine how much you will learn!**

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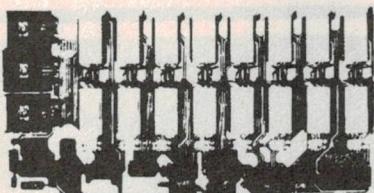
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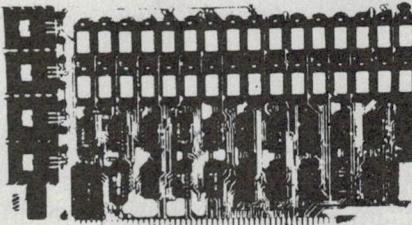
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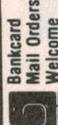
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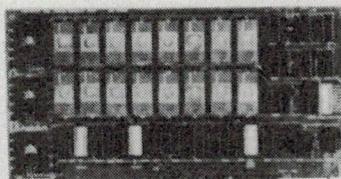
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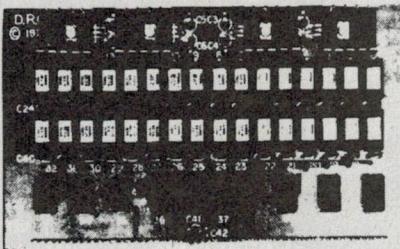
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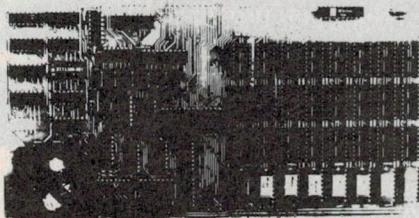


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# 700 ZXL

## Peak Performance Redefined A Triumph of Beauty and Technology

To carry the Nakamichi logo, a recorder must have special qualities. The 700 ZXL Computing Cassette deck is such a deck.

A marriage of classic beauty and technology is the essence of the 700 ZXL. Designed for the devotee of art as well as of music, the 700 ZXL will surprise you in its simplicity. All critical functions are carried out for you by computers.

For example, the time honoured art of user adjustment of a recorder to match each type of tape required test equipment and access to the right internal controls taking time and experience. But not with the 700 ZXL — its inbuilt A.B.L.E. auto calibration processor perfectly adjusts all

four major recording parameters — azimuth, bias, level and equalisation for the tape you are using to achieve a 24 kHz response — and all with the touch of a button!

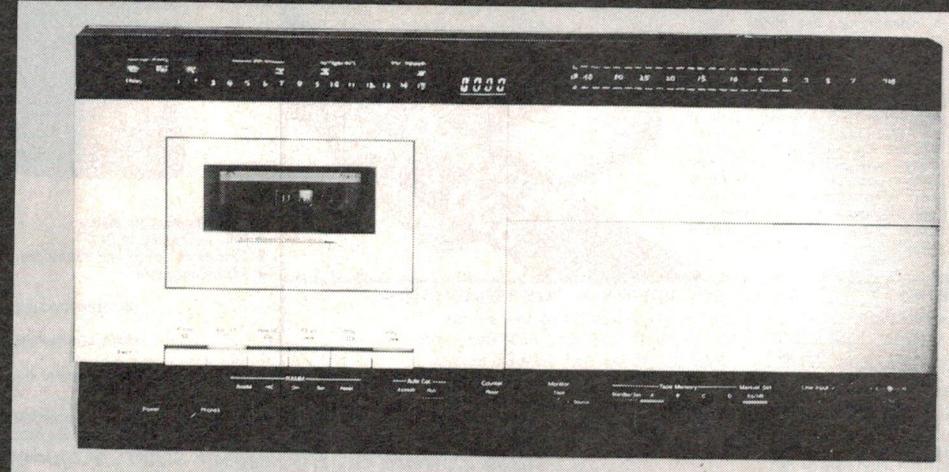
And with the 700 ZXL's new subsonic encoding technique, true error-free random access to any program on tape is now a reality.

And with Nakamichi's Diffused-Resonance transport, discrete 3 head technology, electronic tape counter, 50 dB range digital level meters and an optional remote control for all transport and RAMM functions, the 700 ZXL is truly a triumph of beauty and technology.

For complete information on Nakamichi's 700 ZXL Computing Cassette Deck, see your nearest dealer or write to Convoy International Pty Ltd, 4 Dowling Street, Woolloomooloo 2011.



Nakamichi



# SIGHT & SOUND

## No British blank tape levy

The British Government has decided not to impose a levy on blank tapes in order to be able to pay the recording companies whose records are often taped without authority. Although it is accepted that the recording companies are losing sales, the Government believes the extent of the losses is not known and cannot be measured.

In a Government Green Paper, lost record sales have been estimated to cost the recording companies perhaps £50 million per year, but recovering such a sum by a levy would mean a large increase in the price of blank audio tapes and this is not regarded as fair to the many tape users who do not record copyright music. Even if a levy was made, it could be avoided by simply selling tapes and cassettes with pre-recorded trivial items.

However, the General Manager of the British Phonographic Industry has stated that the income of large numbers of musicians is being threatened by the failure of the Government to impose such a levy. He added that he did not understand why the Government claimed the losses of the recording companies could not be measured.

The Green Paper distinguished between video taping and audio taping: since current video machines cannot copy existing taped programmes unless they are being broadcast, there is no large threat to the manufacturers of pre-recorded video tapes.

The possibility of direct broadcasting from satellites has created some problems for the copyright lawyers, since there are two stages

of transmission, namely up to the satellite and back down to earth. The material transmitted up to the satellite is not intended for public use and is not covered by copyright, but by chance the UK Wireless Telegraphy Act of 1949 makes the reception of such non-broadcast material an offence.

The Green Paper also considered the copyrighting of computer programs. Such material is often held on floppy disks, magnetic tape or on the surface of a chip, where it is less easily accessible than words on paper. However, the British Government intends to introduce new legislation to give computer programs the same copyright protection as literary works. It could however be argued that the displaying of information on a visual display unit is similar to the reading of a book in a library and should not be regarded as a breach of copyright, whereas the making of a 'hard' copy of material held in a computer should be a breach of the copyright laws in the same way that the photocopying of a book already is.

It is quite possible we may see these British decisions reflected in our own laws in the not too distant future — good news for audiophiles, but not so good for software bootleggers!

Brian Dance

## Concept signs with CBS

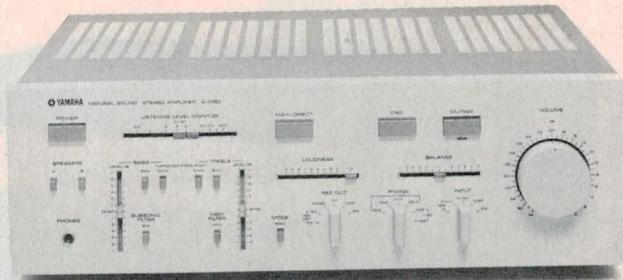
Concept Audio recently announced the signing of a contract with CBS Records Australia Ltd in Sydney, involving the exclusive hi-fi store distribution throughout Australia of their Mastersound Half Speed Master series of recordings.

Immediately available are recent titles from Neil Diamond, Barbra Streisand, Billy Joel and Bruce Springsteen, and also some older titles such as 'Bridge over Troubled Waters' by Simon and Garfunkel and 'Tapestry' by Carole King.

Initially ten such titles will be available, but the catalogue will be expanded very rapidly to en-

compass some of the additional 200 titles that are available from West Germany, where the discs originate.

For further information contact Concept Audio Pty Ltd, 22 Wattle Rd, Brookvale NSW 2100 (PO Box 422, Dee Why NSW 2099). (02)938-3700.



## Three new Yamaha amps and tuners

Yamaha Audio recently announced three new integrated amplifiers and matching tuners: the A-1060, A-560 and A-460 amps, and the corresponding T-1060, T-560 and T-460 tuners.

The A-1060 features Yamaha's X power supply and gives 120 watts per channel, plus having many other powerful features, and retails at around \$1300. The 55 watts per channel A-560 retails at \$380, and the 35 watts per channel A-460 at \$270.

The tuners are all AM/FM stereo and retail at \$480 for the T-1060, \$240 for the T-560 and \$170 for the T-460.

For further information contact Yamaha/Rose Music, 17-33 Market St, South Melbourne Vic. 3205. (03)699-2388.

## New sound level meter

A rugged and compact sound level meter from a British company, which is said to combine low cost with a high specification, is now being distributed in Australia.

A special feature of the instrument is that it can be set quickly and accurately to a reference level by means of a closed coupler unit which permits easy calibration of the meter.

Other characteristics of the Model CS 142C are a dynamic range from 35 dBA to 130 dBA, switched low or fast response, and the incorporation of a conventional 10 dB stepping attenuator with a scale from -5 dB to +10 dB. The microphone is of the air-dielectric type with a plastic

diaphragm and 9 V polarisation.

A 9 V battery powering the meter provides for at least 80 hours of operation, and the instrument measures 175 x 55 x 60 mm, weighing 500 g.

Made by Castle Associates of Yorkshire, England, the CS 142C is distributed in Australia by Instrument Engineering Pty Ltd, 75 Grey St, Brisbane Qld. 4101, and by Paton Electrical Pty Ltd, 90 Victoria St, Ashfield NSW 2131 and 469 King St, Melbourne Vic. 3003.

## New BASF quality tape

BASF recently introduced into Australia the high bias Chromdioxid Super II tape, claimed to consistently provide wider frequency response and less hiss or background noise than other tape types.

A spokesman for BASF claimed that extensive tests had shown the Super II cassettes to be superior in many respects to 'equivalent' competitive brands, and that in independent tests at the Festival du Son in Paris the Chromdioxid Super II had performed better than metal tapes which retail at almost twice the price.

The success of the Super II is said to lie in the development of new techniques in cassette body construction, based on BASF's long experience in the production of chromium dioxide tapes.

For further information contact



BASF Australia Ltd, 55 Flemington Rd, North Melbourne Vic. 3051. (03)329-9555.



# JANDS

## J 1000 CS



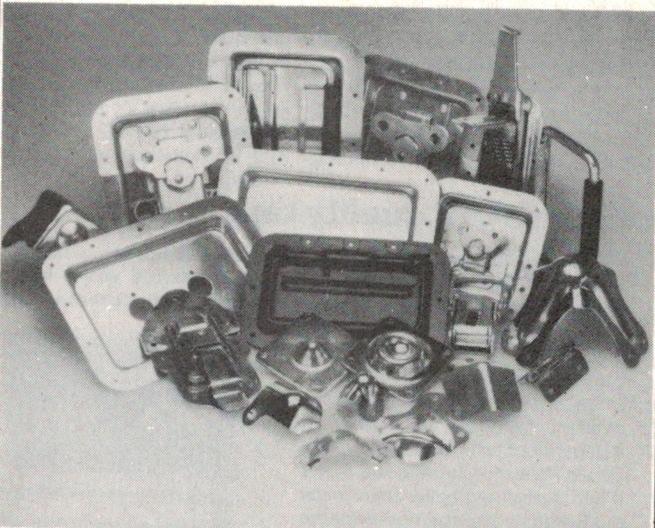
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AVAILABLE J 700 (CS) 350w + 350w  
J 400 (CS) 200w + 200w

".....(this amplifier) may well prove to be the foremost technical development in 1981 for rock music in Australia"  
E.T.I. October 1981

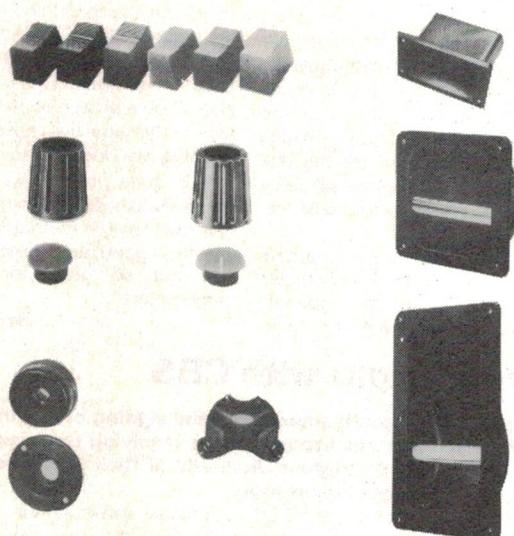
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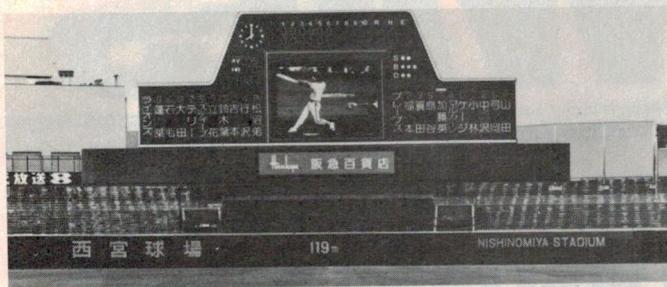


FOR FURTHER INFORMATION ON THESE and OTHER JANDS PRODUCTS

PHONE 516-3622

578 PRINCES HIGHWAY ST. PETERS. P.O. BOX 78 ST. PETERS NSW 2044 AUSTRALIA

 **JANDS**  
AUSTRALIA



## Large-screen colour video from Matsushita

Matsushita Electrical Industrial Co of Japan has developed an ultra-large-screen colour video display system for use in such areas as sports stadiums, auditoria, recreational areas, advertising billboards, promotional displays, theatre backdrops and public information displays.

The screen size of the standard model is 20.6' high by 27.5' wide (6.28 m x 8.38 m) — equivalent to the total screen size of approximately 440 20" TV sets! The screen uses 37 800 coloured bulbs (180 vertically and 210 horizontally) in high-density placement, thus producing high-quality vivid and bright pictures which can be viewed from as close as 170' (51.8 m). Optimum viewing distance is said to be 230' to 500' (70.1 m to 152.4 m). The brightness of the screen may be modified according to surrounding light levels, and images are said to be visible even in bright sunlight.

Many systems of this kind use cathode ray tubes, but Matsushita claims that the newly developed coloured bulbs, which are mirror coated to improve light efficiency, provide many technical advantages over CRTs. The high efficiency bulbs also feature a wide colour reproduction range (64 tone grades) and rapid on/off response.

The system consists of four main units: a central control, the image display, video image driving units, and a power unit. In the central

control unit video images such as moving and still pictures supplied by video cameras, video tape recorders, etc, are processed and transmitted to the driving unit. The transmitted signals are converted into digital signals, which control the change of the electric current supplied from the driving units to the bulbs. According to the change of electric current, the bulbs are turned on and off to reproduce colour images on the screen. Text and graphics may also be displayed.

The large-screen system is said to be easy to install and maintain, and is equipped with an automatic lamp coil breakage detection system.

Matsushita have already received orders from Japan and overseas for the system, and the first one will be in operation towards the end of 1982 at the Nishinomiya Baseball Stadium near Osaka, Japan.

For further information contact Michelle Myers (Publicity Coordinator), National Panasonic (Australia) Pty Ltd, 95-99 Epping Rd, North Ryde NSW 2113. (02)887-0144, ext. 266.

## Denon to sell Philips' digital disc

Denon recently signed an agreement with Philips of the Netherlands for production rights on Philips' Compact Disc Digital Audio System (CD System). Denon's line of home equipment is scheduled to be sold late next year.

It is said to make possible perfect sound reduction, far surpassing anything available today. Using a disc 12 cm (about 5 in) in diameter, with 60 minutes of program time on each side, an optical beam 'reads' the digitally encoded information on the disc, processes it through a decoder, and then sends the signal to the amplifier. This optical 'stylus'

tracks a line of microscopic indentations (digitally encoded music) on a line only 1.6 microns in pitch, about 60 times narrower than the band on a conventional record. Because this line of information is tracked at a constant linear speed, the rotational speed of the disc varies between 200 rpm (at the outside edge) and 500 rpm (near the centre).

## New Hafler amp at Concept Audio

Concept Audio recently announced that the David Hafler DH-500 power amplifier would be available in Australia from October this year.

The DH-200 100 watt MOSFET power amp, introduced in Australia two years ago, proved extremely popular with audiophiles, particularly coupled with the DH-101 Preamplifier, and it is anticipated that the DH-500 will be received just as well.

The amp, which can deliver in excess of 255 watts RMS per channel, features a modular design and is cooled by a three-speed automatic fan. It has a rack-mounting front panel and is finished

in the standard Hafler black.

At a slightly later date a bridging kit will be available to convert the DH-500 into a mono 800 watts RMS unit.

The unit will cost \$1398 in kit form, \$1498 assembled, and a detailed brochure, specifications and any further information may be obtained from Concept Audio Pty Ltd, 22 Wattle Rd, Brookvale NSW 2100 (PO Box 422, Dee Why NSW 2099). (02)938-3700.



## Jaycar stocks Etone speakers

Jaycar now stock a wide range of Etone loudspeakers at their Sydney showrooms, ranging from 6" hi-fi types 605 and 608 through 10" and 12" units up to 100 watts RMS power handling capability.

Etone high-power speakers for PA use are also available, ranging in size from 10" through 12" to 15" and 200 watts power handling capability.

Jaycar also runs a free speaker cabinet advisory service; anyone interested is welcome to drop into Jaycar's showrooms and receive

free design drawings of suitable cabinets for hi-fi enclosures, PA bass bins, foldback monitor boxes, etc. Country and interstate customers may participate by sending an SAE.

For further information contact Jaycar Pty Ltd, 380 Sussex St, Sydney. (02)264-6688.

The result is said to be purity in signal characteristics, and disc surface variables, such as dust or fingerprints, will not affect the performance. And since there is no contact between the optical stylus and the disc, the recording will sound as good after many years of use — it never wears out!

Denon is also attacking the audio accessories market with a new combination: a stylus cleaner and a record cleaner.

The stylus cleaner has incredibly

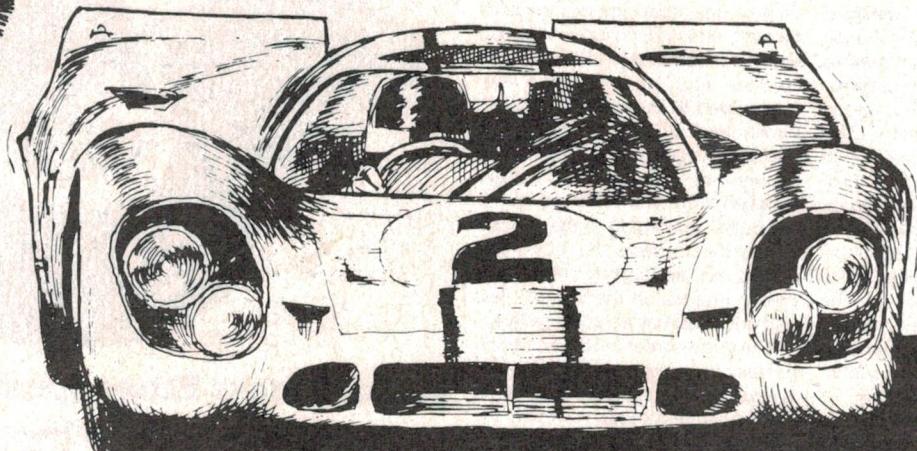
fine glass fibres that vibrate at approximately 400 Hz to safely clean off deposits that build up on a stylus under normal use. The base also functions as a level to check the positioning of the turntable.

To keep records clean, an active vapour record cleaner is also available. Solvent is added to the base pad in the airtight case, causing the vapour of the solvent to be absorbed into the cleaning pad, enhancing the cleaning action without imparting solids to the record surface.

# HotWires

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# The Personal Computer Your information window

## An extension of your brain

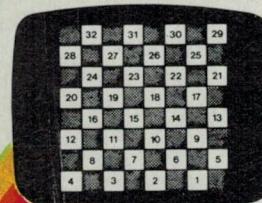
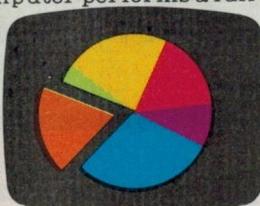
An Apple Personal Computer puts you at the forefront of the technological revolution. Use it well and it will mediate the availabilities of a wealth of conceptual tools, data bases, communication channels and information processes. An Apple will help you simplify a myriad of tasks from ordinary data processing through information retrieval to economic forecasting.

## Apple is versatile

Your Apple is an extremely powerful and robust problem solver backed by a comprehensive set of software programmes. Already, over 300,000 Apples are used for business, domestic, educational research and recreational purposes.

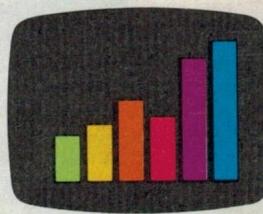
## Apple as information processor

An Apple personal computer performs a full range of standard functions like statistics, word-processing, graphics, number crunching, filing, storage/retrieval and cross-referencing.



## Apple is cost-efficient

For roughly the price of a plain paper copier, you get a sophisticated, powerful machine, which not only processes numbers and words, but gives you direct access to a wealth of information through a rich network of data bases and direct communications with other computers.



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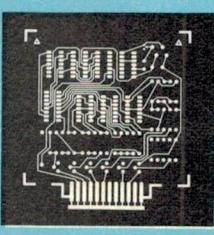
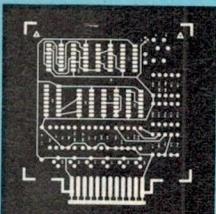
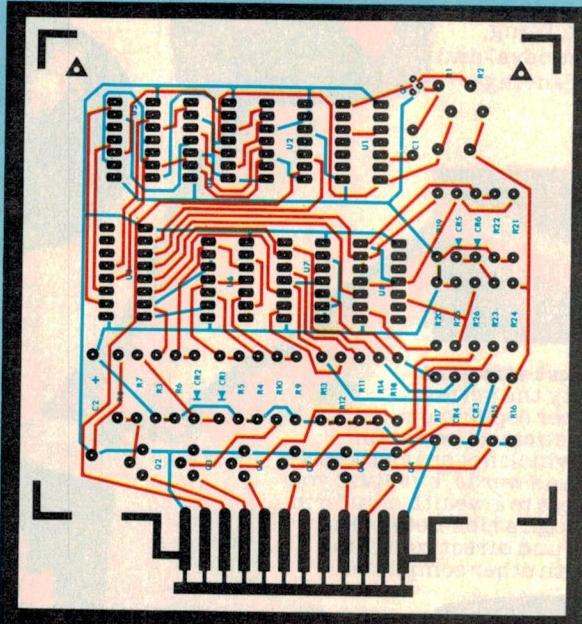
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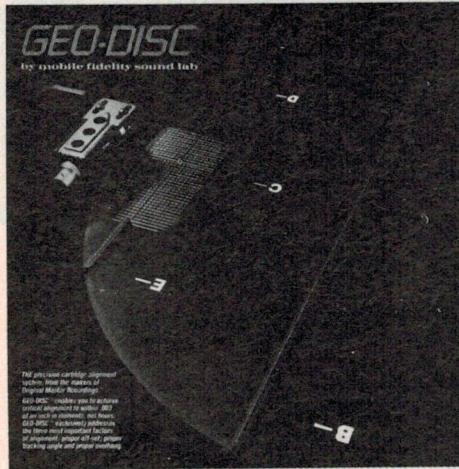
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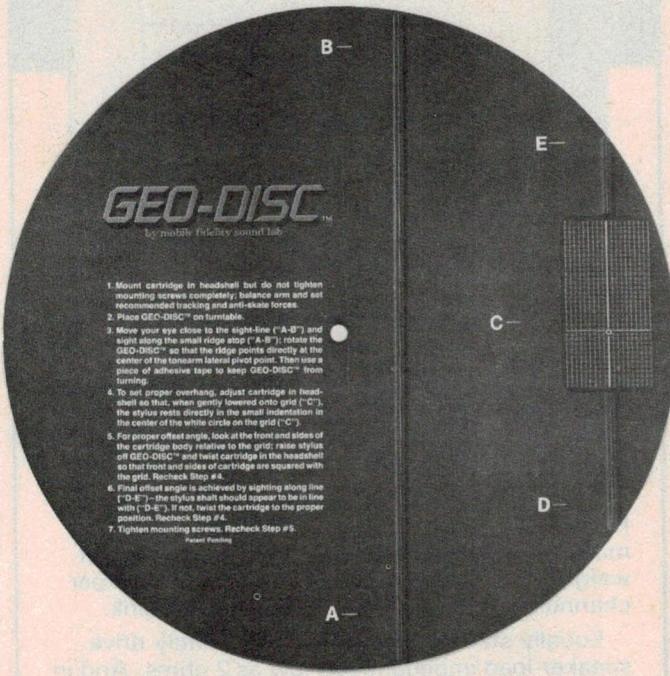
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### THE STATE-OF-THE-ART CARTRIDGE ALIGNMENT SYSTEM. ACCURATE AND EASY-TO-USE.



Total alignment  
in moments,  
not hours.

Critical Alignment  
to within 762 microns  
(.003 of an inch)



Mobile Fidelity Sound Lab's GEO-DISC is the perfect complement to its series of Limited Edition Original Master Recordings. Both will markedly improve the sonic performance of your stereo playback system.

But the high fidelity pleasures of Original Master Recordings . . . even the audio content of conventional records . . . cannot be totally realised if your stylus/cartridge is not aligned accurately. That's where the GEO-DISC is essential.

A product of extensive research and development, the GEO-DISC features a proprietary three-dimensional visual alignment system that delivers incredibly precise, uncomplicated, rapid and economical cartridge alignment. It enables you to achieve critical alignment to within 762 microns (.003 of an inch) in moments, not hours. GEO-DISC exclusively adjusts the three most important factors of alignment: proper offset, proper tracking angle and proper overhang.

The detriments of an improperly-aligned cartridge are legendary and have no doubt affected all concerned listeners from time to time. These include:

- Severe loss of information, frequently lost permanently by groove damage from misaligned stylus.
- Tracking distortion—break-up of high acceleration information.
- Sibilance—break-up of "S" and "T" sounds.
- Phase distortion—inaccurate or lost imaging.
- Tracing error—Loss of subtle details in the recording.
- Frequency response distortion—Loss of some areas in audio band.

Overall, gross cartridge misalignment can result in very high Total Harmonic Distortion. The GEO-DISC can help solve these problems.

Available at discriminating audio stores.  
If your dealer does not carry GEO-DISC you may order direct.

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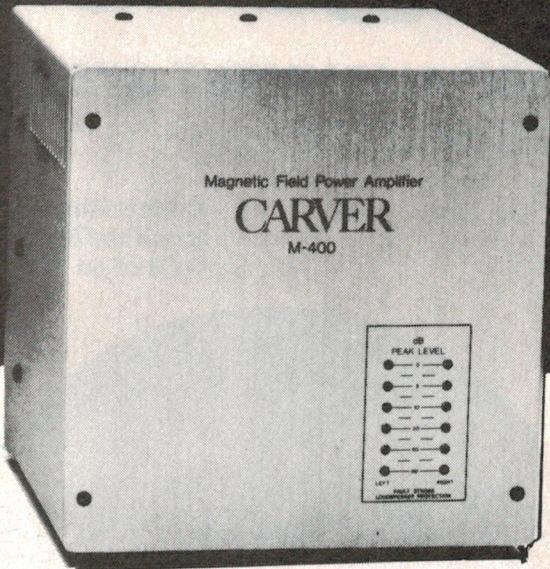
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# The audio experts are raving about the Magnetic Field Amplifier



M-400 Magnetic Field Amplifier

"Its distortion and noise levels are entirely negligible . . . it's hardly conceivable that a small, inexpensive lightweight cube such as this could deliver as much clean power as any but a few of the largest conventional amplifiers on the market."

That's what Julian Hirsch reported in Stereo Review about the Carver M-400—the unique magnetic field power amplifier. It's a cube that weighs around 4 kgs and delivers 200 watts per channel. And costs a lot less than you think.

Equally startling, the M-400 can safely drive speaker-load impedance as low as 2 ohms. And in mono it can deliver more than 500 watts into an 8-ohm load, with peaks to 900 watts! (Bring on digital audio!)

To hear for yourself why all the audio experts have flipped over Carver, ask for a demonstration and descriptive literature. It will be a totally new experience for you.

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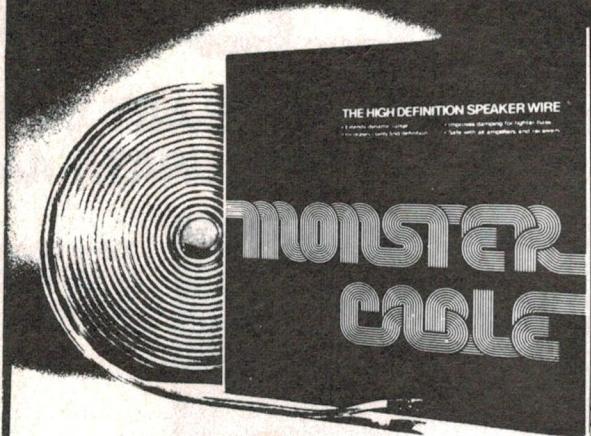
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Deeper, tighter bass.

Maximum power transfer.

Increased clarity and definition.

Wider dynamic range.

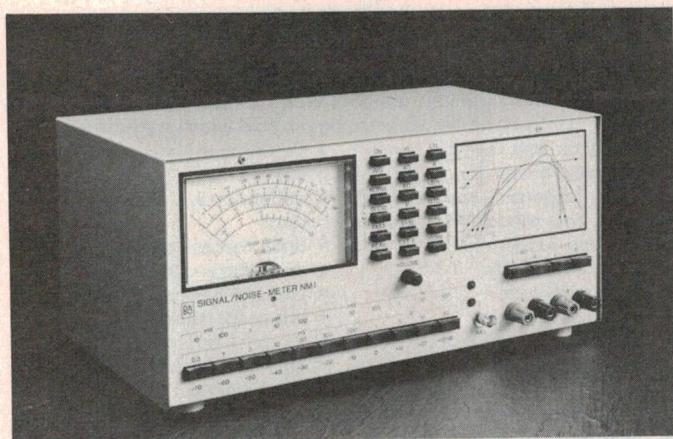
Even low-powered systems show a remarkable improvement. Recommended by leading audio manufacturers, Monster Cable is safe to use with all amplifiers and receivers, regardless of design.

Don't be deceived by imitations. If it doesn't say Monster Cable you're not getting all the performance you paid for.

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## Bang & Olufsen meter available

The latest addition to the Bang & Olufsen range of electronic measuring instruments is the NM1 Signal-to-Noise Meter.

As well as many other features, the NM1 is claimed to be unique because:

- It has weighing networks and meter responses conforming to all internationally accepted standards
- It is the only meter on which an amplifier can be correctly loaded for 4 or 8 ohms and signal-to-noise measurement made.

As a multi-function instrument, the NM1 is said to be very suitable

for measurements of signal noise on, e.g.: amplifiers, AM/FM tuners, tape recorders, record players, various measuring equipment, hearing-aid devices, medical measuring instruments and many other types of AF equipment.

Trade price is \$1270 plus tax, and further information may be obtained from Denis Cale, G.R.D. Group Pty Ltd, 698 Burke Rd, Camberwell Vic. (03)82-1256.



## TDK open-reel tapes line-up completed

TDK (Australia) Pty Ltd introduced its new line-up of both the GX Studio Mastering Series and the LX Professional Studio Series of  $\frac{1}{4}$ " open-reel audio tapes in February 1981, and recently completed their series by adding GX50-120BM, GX50-60B and GX35-180BM models.

Coercivity of the GX series is set at 340 oersteds (27 kA/n) and remanence at 1400 gauss (140 mT). The GX series employs an exclusive graphite/carbon back-coating treatment which forms an extra-smooth coating that is said to lessen friction, assure easier tape winding, reduce modulation noise, and help to eliminate wow and flutter caused by slippage in the tape drive.

The possibility of dropout is significantly reduced because the treatment virtually eliminates elec-

trostatic charges. As a result, dust is not likely to form on the tape's surface.

Recommended retail prices for the GX and LX series are: GX50-120 BM: \$40.00; GX50-60 B: \$16.70; GX35-180 BM: \$47.00; GX35-90 B: \$18.30; LX50-120 BM: \$34.49; LX50-60 B: \$15.30; LX35-180 BM: \$38.16; LX35-90 B: \$16.80; LX35-180 M: \$34.49; LX35-90: \$15.30.

For further information contact TDK (Australia) Pty Ltd, Unit 5, Level B South, 100 Harris St, Pyrmont NSW 2009. (02)660-4955.

## Commercial tape degausser

The Bell & Howell TD-500 degausser is designed for the high energy tape user in the instrumentation, video and audio markets. The TD-500 is claimed to be the first automatic degausser capable of erasing tapes with a coercivity of up to 750 oersted.

The unit can be easily switched from 1" to 2" operation. For commercial broadcast operations the 2" setting is said to be satisfactory for all usage, but the instrumentation user who requires maximum possible erasure would need to set the tape width in use.

The TD-500 is derived from the well-proven TD-2903-4B, with a number of improvements:

- New solid-state logic assembly
- New heavy duty electrical components
- New over-temperature protection circuit

The standard TD-500 is configured for 3" NAB hubs; reel diameters are to 15" and tape widths from  $\frac{1}{4}$ " to 2". Accessory adaptors are available for other tape formats.

For further information contact Bell & Howell Australia Pty Ltd, 55-69 Murray St, Pyrmont NSW 2009 (GPO Box 4778, Sydney NSW 2001). (02)660-5366.

## Vanfi expands

Keio International is a newly formed autonomous company within the Vanfi group, which has been formed to distribute products from the Crown Radio Corporation of Japan. These products include Crown Radio cassette portables, a new up-market range of hi-fi equipment called Vector Research, and the D.R. Industries range of loudspeakers, Silcrown and R.M.S.

Initially in Australia (only the second country after America to market Vector), the Vector Research range will consist of four stereo receivers, three cassette decks and a graphic equaliser and turntable. This range will be complemented in the new year by a full product line of amplifiers, tuners and speakers, and

by a cheaper range of products under the name of 'Bectus'.

The Crown range of portables and the Vector range became available from October this year. For further information contact Bruce Massie, National Sales Manager, Keio International, 19 Cardigan Place, Albert Park Vic. 3206. (03)699-1806.





## Remote control and sound memory — whatever next?

**Sharp's Optonica System 105, previewed at the recent Sydney Hi-Fi and Video Show, is claimed to be the most advanced digital sound system on the market.**

It incorporates a sound control memory for individual settings in its tuner, turntable, amp, tape deck and speaker combination, and other major features include:

- fully remote controlled operation
- advanced digital technology.

The digital remote control unit is extremely compact and thin, and controls all the system's major functions. According to Mr. Geoff Muir, sales and production manager for Sharp hi-fi products, "The unit gives complete control. In fact, the only thing it won't do is change the

records and tapes ... you can even change radio stations by remote control."

By containing all the amplifier's functions on pc boards, Sharp has managed to do away with many potentially troublesome mechanical components. Microcomputers also control the turntable speed and tonearm, the AM/FM tuner and the tape deck.

The Optonica System 105 is expected to retail at around \$2300.

For further information contact Mrs. J.W. Lee Martin, Hutchinson Public Relations, on (02)922-6922.

## Pioneer car cassette player — minimum driver distraction

**The KEX-70 AM/FM cassette component is claimed to have been designed for true hi-fi quality in a car sound system, with added features to provide the minimum of driver distraction in operation.**



## Yamaha tape deck with dbx

**Yamaha's new cassette deck, the K-960, incorporates dbx tape noise reduction circuitry, which is said to reduce noise on cassette tapes by as much as 30 dB with the push of a button during taping.**

This deck also features Sendust record/play heads for better frequency response and reduced dropout and modulation noise, a double-gap ferrite erase head and metal tape capability.

Features include:

- dbx noise reduction
- Yamaha's low-impedance pure plasma process Sendust Rec/Play head
- double-gap ferrite erase head
- metal tape capability
- two-motor separate drive tape transport
- IC logic control

- fluorescent bar-graph peak meter
- continuously adjustable bias control
- timer recording switch
- subsonic and MPX filters
- Dolby noise reduction
- low-noise equaliser amp
- focus switch to extend high-end frequency response or improved phase coherence.

The suggested retail price is \$500, and more information may be obtained from Yamaha/Rose Music, 17-33 Market St, South Melbourne Vic. 3205. (03)699-2388.

## New cassette deck from Sanyo

**The Sanyo RD 10 stereo cassette deck is a new release from Sanyo, and features metal tape capability and Dolby noise reduction for a recommended retail price of \$116.**

Finished in a simulated wood grain cabinet with a brushed silver front panel, the RD 10 also features:

- Two heads
- Full six-function controls
- Auto stop
- Separate left and right micro-

phone input sockets

- Soft eject
- Headphone socket.

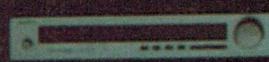
For further information contact Mr. R. Hopwood, Sanyo Australia Pty Ltd, 225 Miller St, North Sydney NSW 2060. (02)436-1122.



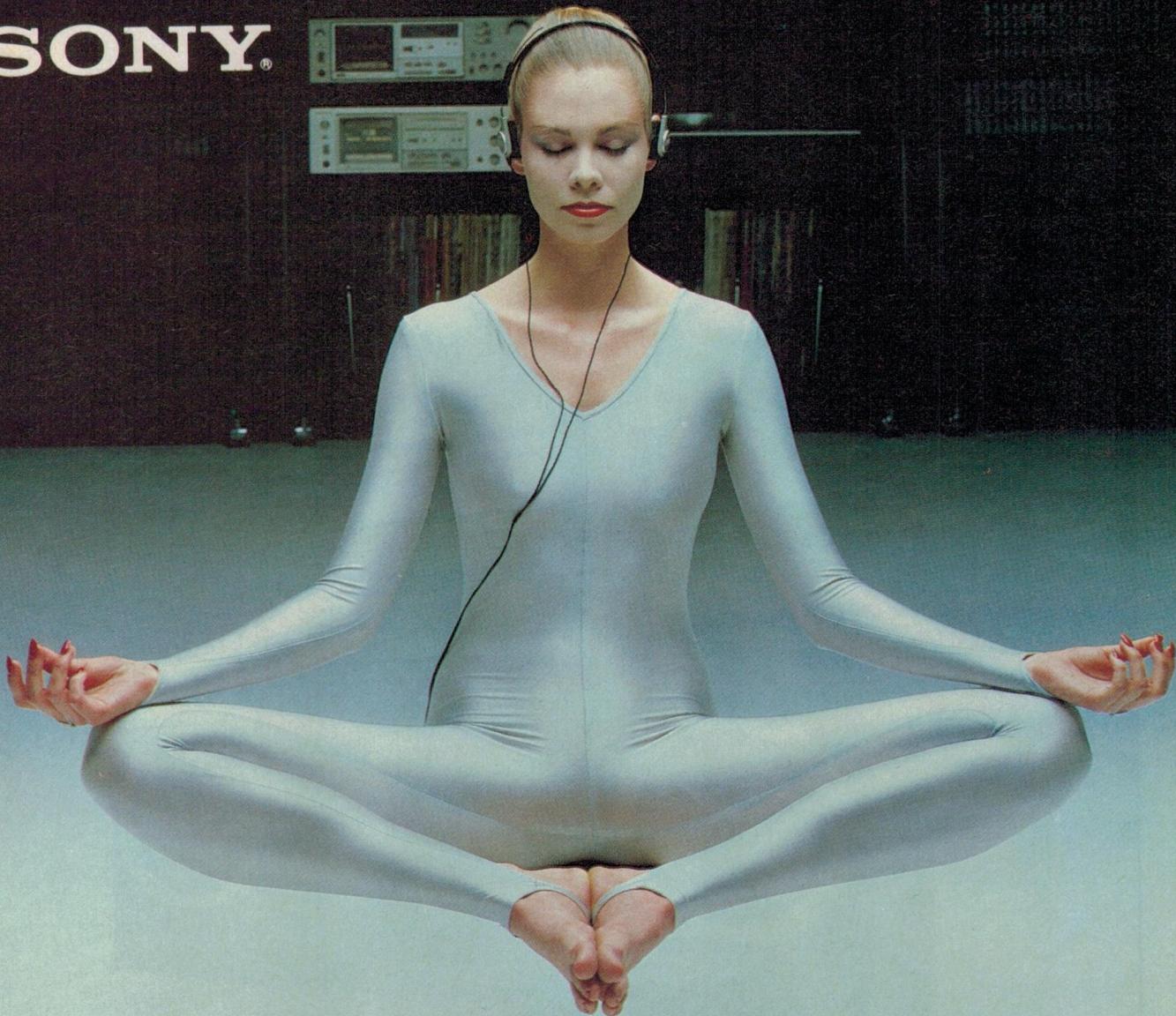
An illuminated cassette loading door provides easier access for night driving, and a remote station control enables the driver to locate a radio station without taking his eyes off the road. Other features include standard Dolby, chrome and metal tape capability and C-90 cassette mechanism.

The tuner section features a station memory for ten FM and five AM radio stations, and has a digital frequency readout which converts to a digital clock at the touch of a button.

Recommended retail price is \$599, and more information may be obtained from Pioneer Electronics Australia Pty Ltd, 178-184 Boundary Rd, Braeside Vic. 3195. (03)580-9911.



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**Additions:** the things added.

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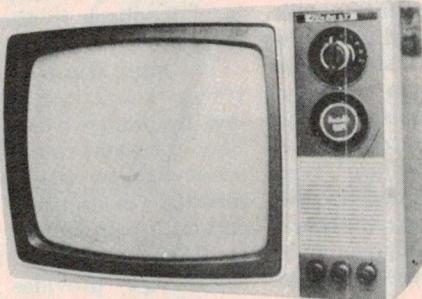
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# High performance audio power amplifier

**Department of Aeronautical Engineering,  
University of Sydney.**

This article, which previously appeared in Australian Electronics Engineering, Sept. 1980, describes the design of a very high performance 25 W audio power amplifier featuring low harmonic and crossover distortion, very stable bias current, large open-loop bandwidth to avoid transient intermodulation distortion, very good square-wave response with capacitive loads and relatively simple design.

**L. Stellema**

THE DESIGN of audio amplifiers is undergoing considerable change, stimulated by requirements for lower distortion and greater stability.

In this article the design of a high performance 25 W power amplifier is described and its performance figures given. The amplifier has extremely low harmonic and crossover distortion, and by a combination of thermal coupling techniques and circuit design, very high stability of bias current is achieved. The circuit also has the advantage of being relatively simple.

To achieve low crossover distortion, two steps are taken. Firstly, open-loop bandwidth is made rather high (15 kHz). Since crossover distortion consists of narrow spikes, feedback is not very effective in reducing these if the open-loop bandwidth is low. Secondly, instead of using conventional Darlington amplifiers in the output stage, the output transistors are driven by emitter followers that have constant current loads. This greatly improves the high frequency characteristics and also provides output current limiting.

Low harmonic distortion of the complete amplifier is achieved by designing each amplifier stage to give low distortion and to have a linear input resistance.

The relatively large open-loop bandwidth should provide low transient intermodulation distortion.



For convenience, the amplifier is split into two parts: a voltage amplifier and a voltage follower (the output stage). The voltage amplifier is built on a printed circuit board, while all transistors of the voltage follower are mounted on one heatsink, Philips or Mullard type 35D2CB ( $\pm 3.4^\circ\text{C/W}$ ). Fastened to the heatsink is a small printed circuit board containing the passive components of the voltage follower. Thus the two parts can be tested separately.

A patent covering the circuitry of the amplifier has been applied for.

## Voltage amplifier

The circuit of the voltage amplifier is shown in Figure 1.

Transistors Q2 and Q3 are connected as a long tailed pair and are preceded by emitter followers Q1 and Q4. This circuit was chosen because of its inherent low distortion and also because the complete power amplifier is connected as an operational amplifier. This circuit is very suitable as a first stage for such use.

The complete power amplifier is an inverting one, the virtual earth point

being at the base of transistor Q1. For this reason the input signal seen by transistor Q1 is extremely small and distortion due to large common mode voltages encountered in some circuits is avoided. Because distortions in transistors Q2 and Q3 cancel to a large extent and the input voltage is very low, the long tailed pair does not need local feedback in the form of emitter resistors.

The input resistance is determined by resistor R1 (22k). Capacitor C1 sets the low frequency 3 dB point at 10.6 Hz. The terminal marked 'feedback' is connected to the similarly marked terminal in Figure 2. Capacitor C4 is chosen to provide a closed-loop high frequency 3 dB point at 48 kHz. Transistor Q1 provides a high input impedance to reduce problems related to offset current and non-linear loading of the virtual earth point. Transistor Q4 serves to compensate for the voltage drift due to temperature variations in transistor Q1. The gain of the first stage is 175.

The emitter followers (Q5 and Q6) prevent the reduction of gain of the first stage due to loading. Of more importance, they reduce the distortion of the voltage amplifier because the load presented by the input resistances of transistors Q7 and Q8 is sufficiently non-linear to cause distortion despite the relatively large emitter resistors R23 and R24 and the push-pull configuration. The emitter followers also

### VOLTAGE AMPLIFIER

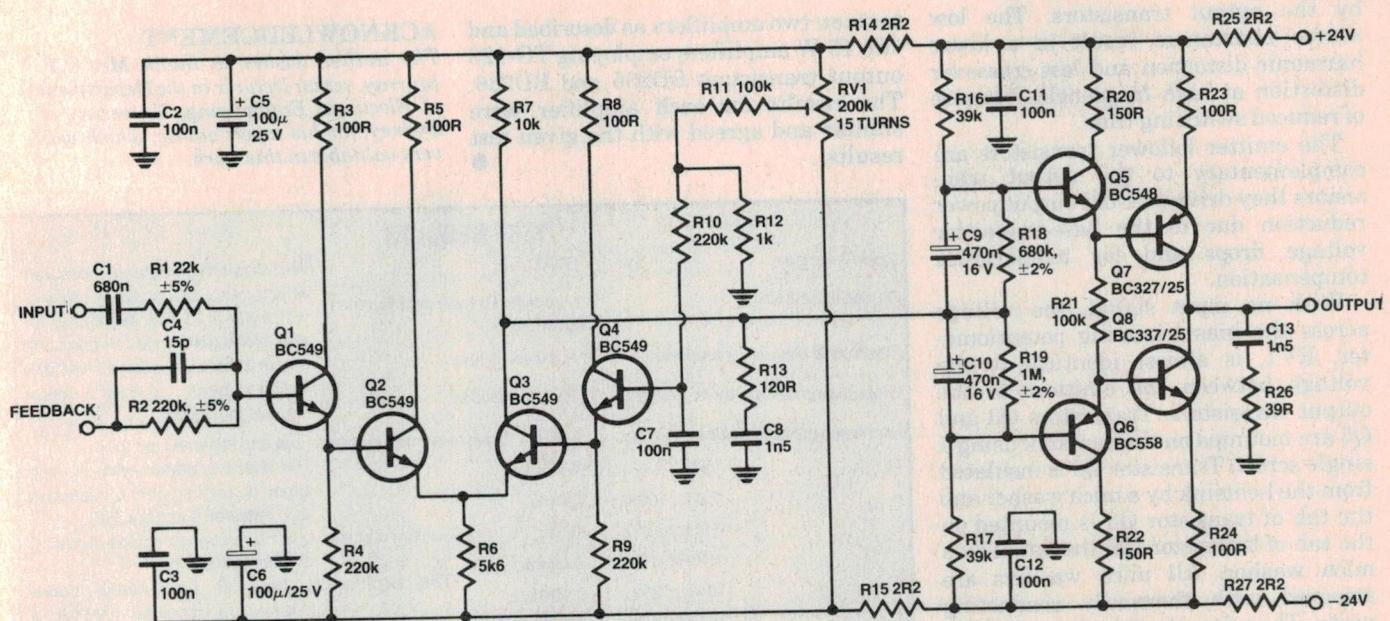


Figure 1. Voltage amplifier. Note that R1, R2, R18 and R19 are metal film types. Capacitors C9 and C10 are tantalum or plastic foil types.

### PARTS LIST

All resistors used are  $\pm 5\%$   $\frac{1}{4}$ W carbon film types unless specified otherwise.

#### VOLTAGE AMPLIFIER

##### Resistors

R1	22k
R2,R4,R9,R10	220k
R3,R5,R8,	
R11, R21	100k
R6	5k6
R7	10k
R12	1k
R13	120R
R14,R15,R25,R27	.2R2
R16,R17	39k
R18	680k, $\pm 2\%$ , metal film
R19	1M, $\pm 2\%$ , metal film
R20,R22	150R
R23, R24	100R
R26	39R
RV1	200k, 15 turns

##### Capacitors

C1	680n
C2,C3,C7,	
C11,C12	100n
C4	15p
C5,C6	100 $\mu$ /25 V
C8,C13	1n5
C9,C10	470n/16 V tantalum or plastic foil

##### Semiconductors

Q1-Q4	BC549
Q5	BC548
Q6	BC558
Q7	BC327/25
Q8	BC337/25

stabilise the quiescent current through transistors Q7 and Q8, because changes of the base to emitter voltages of these transistors, due to variations in ambient temperature, are compensated by the change in the base to emitter voltages of transistors Q5 and Q6. The emitter followers also prevent reduction

in bandwidth due to Miller capacitances of transistors Q7 and Q8.

The quiescent current through transistors Q7 and Q8 is approximately 10 mA. At full output, the current in each transistor swings between 5 mA and 15 mA. A higher quiescent current would result in lower distortion; however, as medium-power transistors with a relatively high  $f_T$  should be used, a compromise of 10 mA was made.

Harmonic distortion in the second amplifier stage is very low due to the fact that it is a push-pull amplifier and the emitter resistors R23 and R24 are of relatively high value.

Capacitors C8 and C13 are for frequency compensation. With the chosen values, the open-loop high frequency 3 dB point of the complete amplifier is 15 kHz. The resistors R13 and R26 reduce the phase shift at those high frequencies at which the reactance of the capacitors becomes very low, thus increasing the stability. Without these resistors, the capacitors must have a much higher value.

The second stage is coupled to the first via two capacitors C9 and C10 and via the dc attenuator, consisting of resistors R16, R17, R18 and R19. When the zero set control, RV1, is set for zero output voltage, the voltage at the collector of transistor Q3 is approximately 4 V and the collector currents of transistors Q2 and Q3 are approximately equal, due to different values being used for resistors R18 and R19. Owing to the use of the dc attenuator, the zero set control can be used for the whole amplifier and the

setting is very uncritical. If the base-emitter voltages of transistors Q1, Q2, Q3 and Q4 are roughly matched, no zero set control is required, except when trouble-shooting with the feedback loop removed.

Components R14, R15, R25, R27, C2, C3, C11 and C12 prevent high frequency oscillation due to parasitic coupling via the supply leads. Electrolytic capacitors C5 and C6 are employed for decoupling purposes.

The gain of the voltage amplifier when loaded with the voltage follower is 5000. With the compensation capacitors C8 and C13 removed, the high frequency 3 dB point of the first stage is 220 kHz and that of the complete voltage amplifier 180 kHz when loaded with the voltage follower.

Resistors R3, R5, R8, R20 and R22 are used to stop any possible oscillation due to lead inductance, to limit collector currents in case of breakdown, and to aid in trouble-shooting.

### Voltage follower

The circuit for this stage (output) is shown in Figure 2.

Output transistors Q5 and Q6 are driven by emitter followers Q1 and Q3, which are also loaded by constant current loads (Q2 and Q4). This produces source resistances for the output transistors which at all times (even when the output transistors are switched off) are very low. The constant currents selected by resistors R5, R6, R7, R8 and R9 should be higher than the worst-case peak base currents required

by the output transistors. The low source resistances result in a lower harmonic distortion and less crossover distortion at high frequencies because of reduced switching time.

The emitter follower transistors are complementary to the output transistors they drive to avoid output power reduction due to the base-to-emitter voltage drops and for temperature compensation.

With no input signal, the voltage across the bias trimming potentiometer, RV1, is almost identical to the voltage between the emitters of the output transistors. Transistors Q3 and Q5 are mounted on the heatsink using a single screw. Transistor Q5 is insulated from the heatsink by a mica washer and the tab of transistor Q3 is mounted on the tab of transistor Q5, insulated by a mica washer. All mica washers are smeared with thermally conducting paste. Therefore the junction temperature of transistor Q3 follows that of transistor Q5. Transistors with a hole in them (TO-126) can be mounted together with the metal side of the emitter followers fitted against the insulated side of the output transistor. No mica washer is required, but the use of thermally conducting paste improves the thermal coupling.

The ideal bias current for an output transistor is a current that produces 25 mV across each emitter resistor. Since this emitter resistor is one-quarter ohm, the bias current should be 100 mA. However, since the emitters of the transistors will have some small ohmic resistance, a 90 mA bias current was chosen. The bias current value is not critical at all.

The components L1, C3, R14 and R15 are the normal output stabilising components. The feedback is taken from the junction of resistors R12 and R13. These resistors are used to avoid using an unsuitably high value for resistor R2 in Figure 1. When both resistors are equal (say 4k7) the closed loop gain is 20.

The resistive network consisting of resistors R1, R2, R3 and R4 and trimming potentiometer RV1 provides a load to the voltage amplifier which is much lower than the relatively high but slightly non-linear input resistance of the emitter followers (Q1 and Q3). This keeps the distortion low.

## Conclusion

A power amplifier designed according to the circuit as described in this article has an extremely high performance. This was confirmed by the results of

tests on two amplifiers as described and two 15 W amplifiers employing TO-126 output transistors BD235 and BD236. The results for each amplifier were similar and agreed with the given test results.

## ACKNOWLEDGEMENT

The author wishes to thank Mr. C.T. Murray, senior lecturer in the Department of Electrical Engineering, University of Sydney, for his expert advice, which was very valuable in this work.

## TEST RESULTS

Open-loop gain:	5000	All distortion figures were measured at just below the onset of clipping, which was at 25 W or slightly higher, with a load resistance of 8 ohms. As output power is reduced, the distortion goes quickly below measurable levels.
Closed-loop gain:	Minimum 10 (with circuit values given 20)	
Open-loop frequency response:	10 Hz to 15 kHz	
Closed-loop frequency response:	10 Hz to 48 kHz	
Harmonic distortion at 1 kHz, 10x:	0.001%	Square-wave response: Rise and fall times are 7 $\mu$ s.
1 kHz, 20x:	0.002%	The shape is perfect with no overshoot or ringing with a capacitive load between 0 and 0.47 $\mu$ F.
1 kHz, 100x:	0.01%	
1 kHz, 5000x:	0.5%	Bias current stability: Maximum change in bias current is $\pm 1.5$ mA or $\pm 1.7\%$ .
10 kHz, 10x:	0.004%	
10 kHz, 20x:	0.008%	Test conditions: 1 hour at zero output power followed by 1 hour at 10 W output power (maximum dissipation of output transistors).
10 kHz, 100x:	0.04%	
10 kHz, 5000x:	1%	

## VOLTAGE FOLLOWER

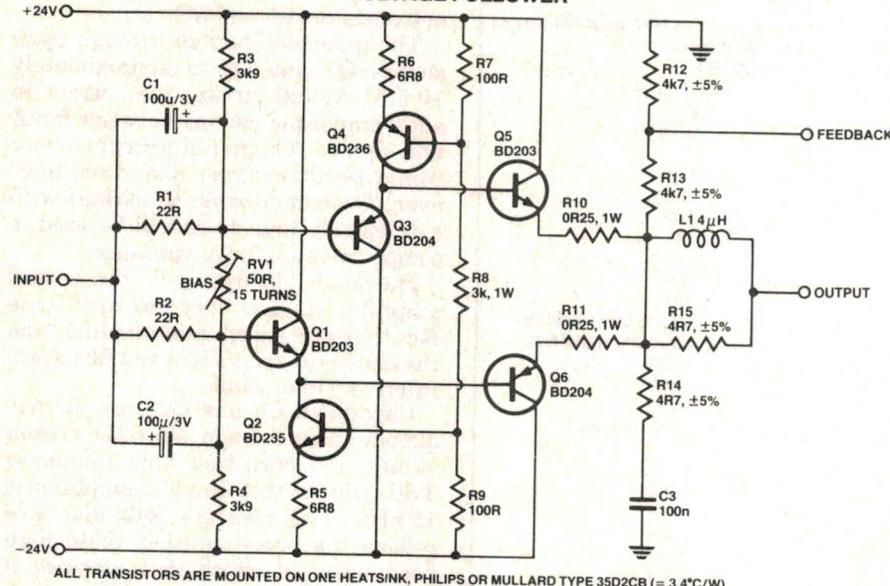


Figure 2. The voltage follower stage. Note that R12 and R13 are metal film types, while R14 and R15 are carbon film types.

## VOLTAGE FOLLOWER

All resistors used are  $\pm 5\%$  1/4W carbon film types unless specified otherwise.

### Resistors

R1, R2	22R
R3, R4	3k9
R5, R6	6R8
R7, R9	100R
R8	3k, 1W
R10, R11	0R25, 1W
R12, R13	4k7, $\pm 5\%$ , metal film
R14, R15	4R7, $\pm 5\%$ , 1W, carbon film
RV1	50R, 15 turns

### Capacitors

C1, C2	100 $\mu$ /3V
C3	100n

### Semiconductors

Q1, Q5	BD203
Q2	BD235
Q3, Q6	BD204
Q4	BD236

All transistors are mounted on one heatsink, Philips or Mullard type 35D2CB ( $\approx 3.4^\circ\text{C}/\text{W}$ ).

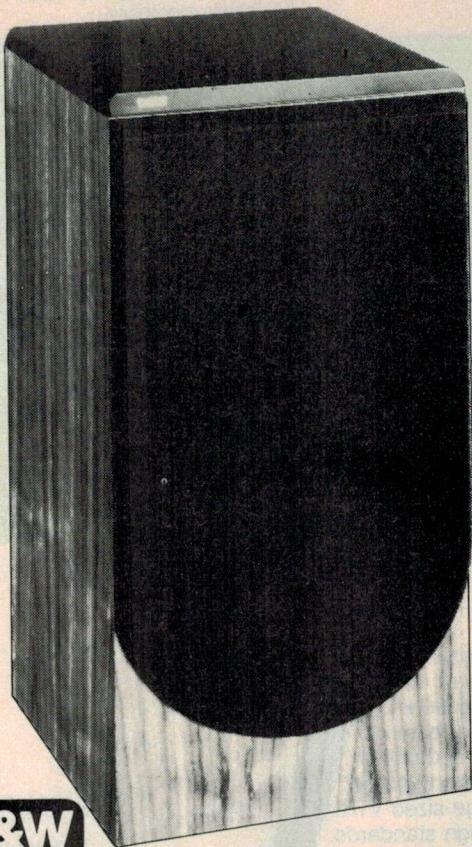
### Miscellaneous

L1	4 $\mu$ H
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# B&W DM 22

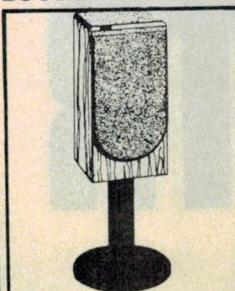
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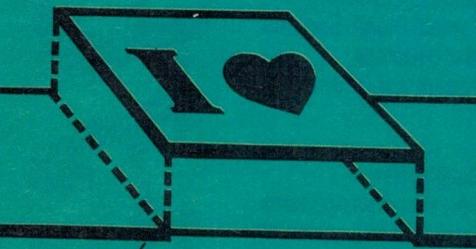
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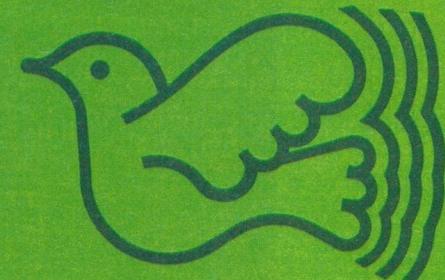
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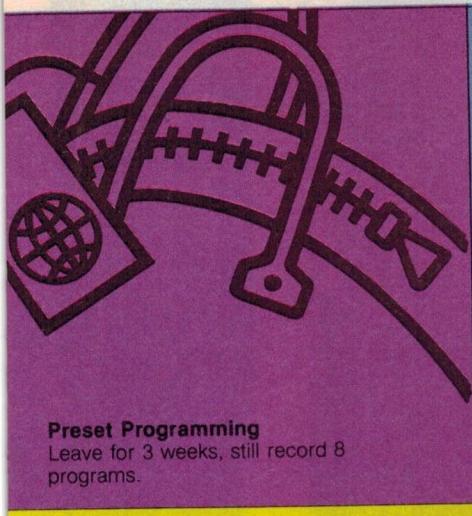


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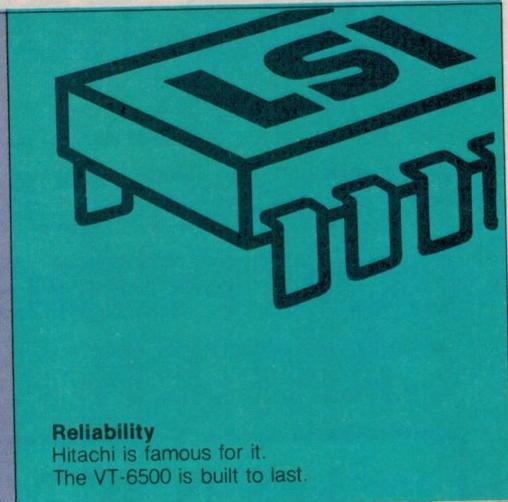
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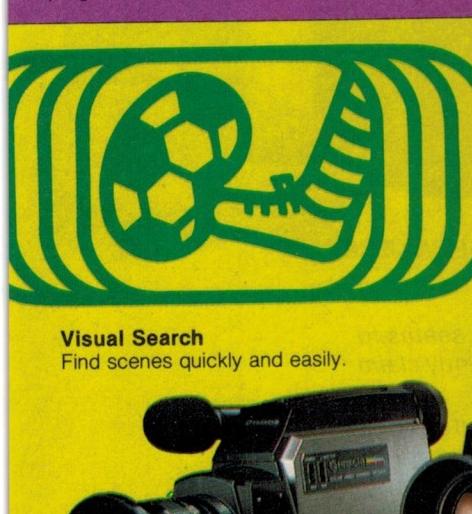
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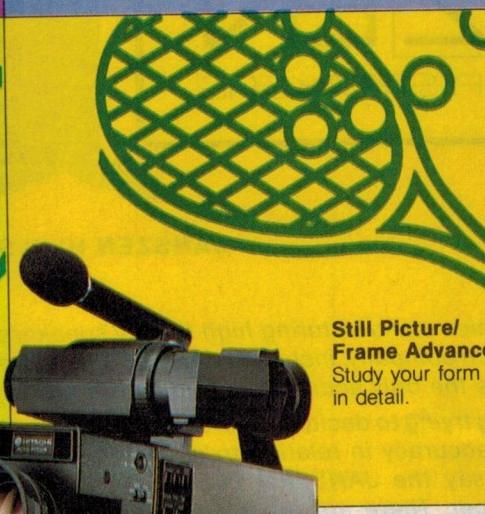
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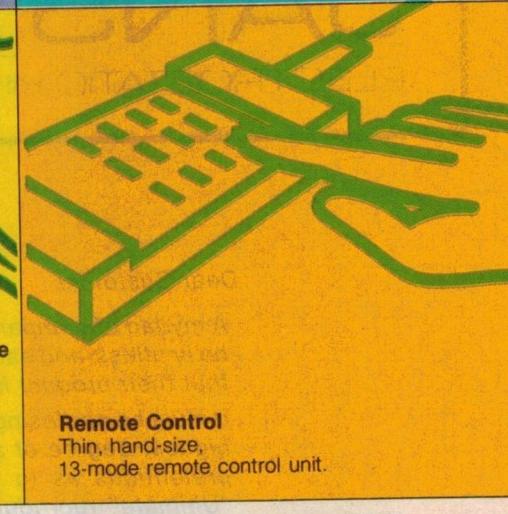
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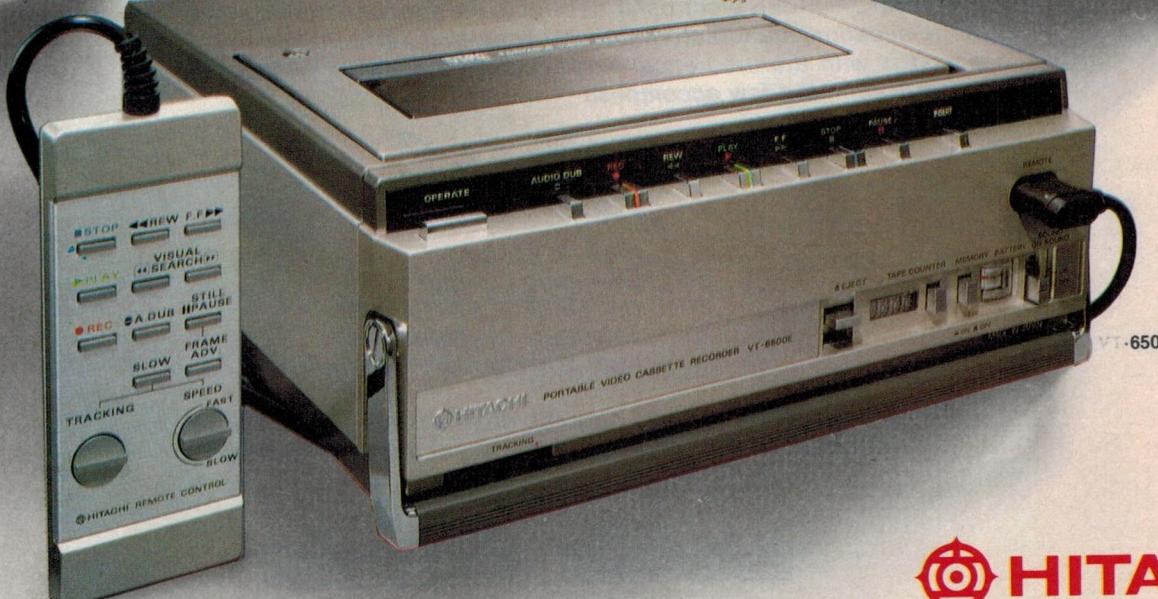
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Sincerely  
*Nigel V. Cowan*

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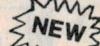


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# Carver M400 magnetic field power amplifier

The M400 embodies a totally new concept in amplifier design, pioneered by its designer Bob Carver. It is claimed to overcome distortion problems and is based on a completely new approach to the basic power supply.

OVER THE LAST two years no amplifier has produced as much market and consumer interest as the Carver Model M400 Magnetic Field Power Amplifier. It has raised many eyebrows, not the least our own, and created many arguments as to the merits of the original American music power rating, continuous sine wave or RMS power ratings and the approach promoted by Bob Carver in marketing and developing this particular unit.

## History

When the first transistorised amplifiers came out some twenty years ago the purists and musicians amongst us were quick to tell you that we could detect a difference in sound between those new-fangled amplifiers and that produced by the best valve amplifiers. That difference in sound was, as we now know, primarily the result of class B operation crossover distortion, which produced a subtle difference in sound that was audible and, for many people, disturbing. As amplifier designs improved not only did designers overcome those problems of crossover distortion, but the best transistorised amplifiers' THD distortion figures have improved to the point where no valve amplifier can readily touch them.

Now, out of the blue, Mr. Bob Carver came up with a new amplifier design, with which he claimed to have obviated all those nasty problems of the first generation transistor amplifiers. This design is based on a difference in approach for the basic power supply and an even stranger approach for solving the distortion and crossover problems.

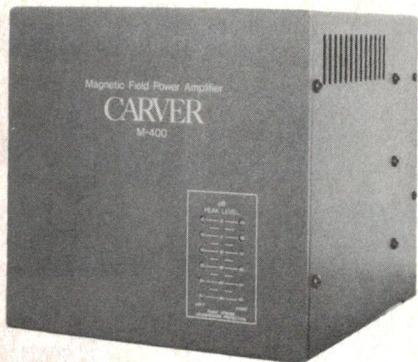
## The M400

The Carver amplifier is exceptionally small, with dimensions that really belie

its potency and capabilities. This, however, is really a secondary attribute compared with its design philosophy. Unlike other amplifiers, which work on the principle of stable or regular dc supplies and are then used with either class A, B, AB or lesser-known circuit techniques in the output stage to achieve the stated output, the Carver Model M400 uses an entirely different approach. According to Bob Carver, the main reason underlying his development of the 'Magnetic Field Amplifier' (as he dubbed it) was the need to produce an amplifier which achieved a far higher efficiency through varying the dc supplies to follow reasonably closely the actual acoustical output required by the amplifier.

This is achieved by what Carver describes as a form of commutation (switching), where the positive-going and the negative-going excursions of the output signal are derived from three separate dual power supplies operating at voltages of  $\pm 25$  volts,  $\pm 50$  volts and approximately  $\pm 80$  volts. The output power signal is then controlled by the input signal to produce a step-wise excitation, with three steps of the voltage supply to the positive and negative output rails of the main output transistors. This signal is then modified by an amplified feedback circuit, which acts as a low power control amplifier, to remove the distortion components (from the 'steps-and-stairs' type waveform applied to the output circuitry) and achieve a faithful and low-distortion equivalent of the amplified input signal.

If this sounds more complex than a normal amplifier, it unquestionably is, but the important thing is that the system works and, all things being equal, works fairly well.



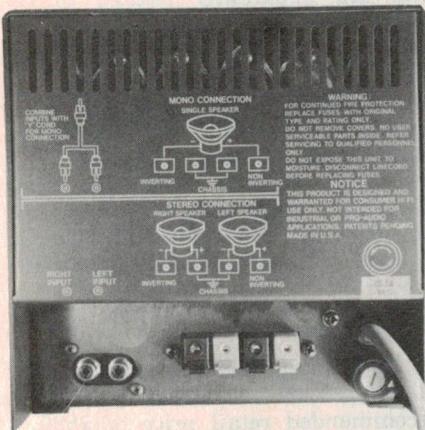
## Louis Challis

There are two problems with such a system. The first relates to the commutation noise which normally occurs at frequencies lying in the audible range and above, which consequently can be a source of intermodulation noise. The second is that the power handling capacity of the amplifier is geared to what can be described as a 'music power rating' rather than a continuous power rating. This can be likened to using a very high-powered amplifier with smaller than normal heatsinks, which can provide normal output power on the peaks of the signal but not on a sustained or continuous basis.

Carver's design philosophy, of course, was that this amplifier would not be used by rock groups, or by people needing servo-amplifiers or to drive foghorns, but rather for people interested in playing music, where the music does not have a continuous background high level, but rather is 'real' music.

The first version of this amplifier which I saw was a bright anodised unit. With the latest black version, featuring two simple arrays of light emitting diodes on the front face, and four speaker terminals and two coaxial input terminals on the rear face, one appreciates that this has been designed for the utmost in simplicity. On reading the handbook, you are aware that the designer has taken great pains to incorporate a series of protection circuits to stop you from destroying the amplifier even if you do not read the handbook.

It thus contains an over-current trip circuit, a clipping detector, a differential low frequency trip circuit, an over-voltage trip circuit, an over-temperature trip circuit and a dc fault trip circuit. In practical terms one does not have access to any of these circuits,



All the interconnections are clearly explained on the rear of the M400 for either mono (bridged) or stereo operation.

for when they operate it is only necessary to remove the fault or to let the amplifier cool down for it to reset itself into the normal operating mode.

The output connections for the speakers are wired differently to those with which most of us are familiar. The black terminal of the right channel pair is at ground, whilst the left channel grounded terminal is coloured red. The two channels of the amplifier thus deliberately deliver out-of-phase signals compared to one another and the terminals are thus marked with the reverse colour code in order to provide the correct phasing compared with the input signal. For mono operation the two input signals are combined at the coaxial circuits and the output is taken from the two furthest sockets, with the two inner terminals already being grounded in the chassis connection. Provided one follows the normal colour coding procedures in connecting the speakers, the system works quite normally and without problems. The back panel presents clear instructions on how to connect the speakers correctly and how to make a mono connection should this be required.

### Measuring problems

The previous version of this amplifier, which was virtually a prototype 240 volt unit, provided us with the opportunity to evaluate many of the most important claims made by Carver for the unit. The first of these related to its power output capability, which we had some difficulty measuring at first. The theoretical approach that one would normally employ of applying a steady state signal at maximum power level is inapplicable and electrically

unacceptable to this particular amplifier unless you can do it *very fast*. We had to revert to driving the amplifier with tone burst, whose distortion components and power working level characteristics were the subject of considerable time, effort and some ingenuity.

The first Model M400 we saw (Serial No. 7255) was an Australian prototype (that is, a prototype of what was intended for sale in Australia) and it produced a considerable level of commutation noise that was audible, even to an untrained ear. That unit was returned to the agents and some two months later a new production model (Serial No. 9956B) turned up for re-evaluation. It is this unit that we are reviewing and our comments relate entirely to it.

### On test

The objective testing of the M400 provided us with the opportunity to reapply the measurement techniques, which we had refined in the intervening period, especially to be able to accurately determine the 'real parameters' of this amplifier. Obviously frequency response tends to be a second-order factor in the evaluation, and so it was, as our measurements showed that the performance of the amplifier is within 3 dB from 1 Hz to 86 kHz.

If one measures the harmonic distortion in the normal manner, that is by evaluating the second, third, fourth, fifth and higher order harmonics as we normally do, the distortion products at the rated power of 201 watts and at the normal 1 watt level are *exemplary*, and if anything better than the manufacturer has previously claimed. Thus the total harmonic distortion is never more than 0.02% at the three test frequencies at 201 watts, and is 0.03% at 6.3 kHz in the case of the 1 watt level.

This, however, is not the full story, for when one closely examines the spectrum analysis produced by the real time fast Fourier analyser which we use in this mode of operation, one sees that there are commutation products which, if they were capable of being measured by a normal noise and distortion meter, boost the total indicated noise and distortion products to a far higher figure, more typically 0.3% than 0.03%.

It is possible to argue that these commutation noise components, which are readily measurable and also readily visible in the analysis procedure, are not 'true' harmonic distortion com-

ponents. It is most probably equally true to argue that they come as a result of the mode of generation of the power supply signal and thus are really a form of intermodulation noise. This intermodulation noise then interacts with the test signals being used for the distortion analysis and is bordering on the audible under special conditions which relate to the level of the input signal. Obviously, with music being generated these components would be even more pronounced and undoubtedly more readily measurable if one happened to pick the right sort of spectrum and generate it in the right sort of way. When subjected to a normal intermodulation distortion test there is no denying that the intermodulation components are not readily measurable and so in this respect the manufacturer's claims are most certainly proved.

When it comes to noise and hum levels, if one follows the standard procedure of putting in a signal corresponding to the 1 watt level, and then measuring the noise components related to that, it is clear that the unweighted level is -82 dB and that the A-weighted level is -84 dB. This falls short of the very best amplifiers that we have evaluated, but even more significantly it avoids the key issue of what happens in the amplifier when it is subjected to a *real* signal. Under these conditions our measurements showed that the noise level (if we can describe it as that) rises rapidly and is typically -55 dB down with respect to the peak signals at maximum output level. This shows up in photo B in the form of commutation background noise, which does not occur in a more conventional amplifier. It is at least 25 dB higher than in a conventional 'run of the mill' amplifier and at least 35 dB higher than in the very best amplifiers we have tested.

The maximum power output capability is *every bit as good* as the manufacturers claim, and the clipping level occurs at 248 watts output into an 8 ohm load. Under these conditions there is a 0.9 dB headroom relative to the 20 watt power level.

The overload recovery characteristics of this amplifier had to be evaluated in a slightly different way to the normal, in that when subjected to a continuous power level at the rate of 201 watts the amplifier rapidly shuts down, so we had to pick a reference point that was some 10 dB down with respect to the maxi-

mum rated power in order to be able to evaluate the amplifier's performance. Notwithstanding, the amplifier's recovery is rapid and normal. In subsequent subjective and objective testing we found that there were no hang-ups in this respect whatsoever. Likewise, when subjected to a short circuit on the output or anomalous electrical connections the overload protection circuit functioned completely reliably and effectively.

The inside of the unit is an absolute delight to behold, for it consists of a *very, very small power transformer* located on the bottom of the chassis, with electrically isolated mechanical connections, and a series of remarkably small epoxy glass printed circuit cards. These are interconnected by means of a series of unusual power transistor sockets located on an internal subchassis at the rear of the amplifier. The components that have been used are primarily of normal American and Japanese consumer electronics origin, with the exception of the output transistors, which are matched sets of selected Motorola power transistors. These are mounted on a remarkably small heatsink, which uses the main chassis as a supplementary radiating element. When one looks at the amount of electronics incorporated in this unit you gain an even greater respect for what Bob Carver has achieved.

One natty design feature, which is in keeping with something that I have often done myself, involves the use of silicone adhesive to hold the printed circuit card with the LED array for indicating peak power level and strobe faulting on the front panel of the unit. This plugs into a simple socket in the main unit.

## To the ear

The most important test of an amplifier of this type still lies in the realm of the subjective test, where the amplifier's performance, when connected to other high-quality components, tends to be subjected to what can well be described as the 'acid test'. For this particular test, the amplifier was connected to a Yamaha C-4 Natural Sound preamplifier. The drive signals were provided by an AIWA AD6900 cassette recorder and Technics SL1200 record player. This record player was fitted with a Shure SME arm and Audio-Technica AT30E moving coil cartridge. The output of the amplifier was fed to a pair of B&W 801 loudspeakers capable of handling the 200 watts a side without complaint. For reference purposes a Yamaha M2 power amplifier, with power rating slightly greater than that of the Carver, was used as a yardstick.

The programme content used for the evaluation consisted of a new Telarc digital recording (10042) of Lorin Maazel conducting the Cleveland Orchestra with Moussorgsky's 'Pictures At An Exhibition' and a Digital Mastering Direct Cassette, 'Classics Live' Concert Volume 2 (DM002), from Nakamichi Corporation, Tokyo. The main reference passage was taken from the Symphonic Poem 'Sorcerer's Apprentice'.

In terms of sheer power, the M400 displayed outstanding performance. Intermittent peaks of 105 decibels were readily produced at 4 m from the speakers, with regular peaks of over 100 decibels for at least 5% of the time. Whilst normal distortion was inaudible, there were some clear subjective differences in the sound compared with the conventional power amplifier.

These differences are subtle in nature, and are apparently related to the commutation mechanism.

In many other reviews I have stated that I could not detect any difference in sound between the amplifier being reviewed and the other reference amplifiers which I was using. In this particular case I feel that such differences are just audible, primarily at the highest output levels rather than at low levels where they are apparently inaudible.

## Summary

The M400 amplifier has a potency out of all proportion to its size, and at a recommended retail price of \$820 is approximately \$2 per watt. This is comparable or slightly better than other amplifiers in the same performance range, but this amplifier is smaller, very much neater and as we found, virtually impossible to destroy.

The Carver amplifier is clever, innovative, and very powerful. It achieves the majority of the parameters claimed for it, only falling short in terms of the 'active, or dynamic, signal-to-noise ratio'.

## CARVER M400 MAGNETIC FIELD AMPLIFIER

Dimensions:	180 mm high x 175 mm wide x 178 mm deep
Weight:	4.3 kg
Price:	\$820
Manufactured:	In America by the Carver Corporation.
Distributed by:	Convoy International, 4 Dowling St, Woolloomooloo NSW.

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MEASURED PERFORMANCE OF CARVER M400 MAGNETIC FIELD POWER AMPLIFIER S.N. 9965B			(B)	(At 1 Watt into 8Ω )	100Hz	1kHz	6.3kHz
<b>FREQUENCY RESPONSE:</b>							
(-3dB re 1 Watt, 0.5V Input to Aux)	Left 1Hz to 86kHz Right 1Hz to 95kHz		Tone Controls Defeated		2nd	-84	-80
					3rd	-88.4	-94.2
<b>SENSITIVITY:</b>	<u>Left</u>	<u>Right</u>			4th	-95.3	-86.6
(for 1 Watt in 8Ω ) AUX	90mV	92 mV			5th	-	-98.6
<b>INPUT IMPEDANCE:</b>	<u>Left</u>	<u>Right</u>			THD	0.0076	0.011
AUX	15 kΩ	15 kΩ					0.03%
<b>OUTPUT IMPEDANCE:</b>	90 milliohms (@ 1kHz)						
<b>HARMONIC DISTORTION:</b>	(A) (At Rated power of 201 Watts into 8Ω = 40.1 Volts)			100Hz	1kHz	6.3kHz	
	2nd	-80.9	-	-85.1dB			
	3rd	-80.6	-74.3	-83.8dB			
	4th	-76.8	-	-88.9dB			
	5th	-77.8	-	-dB			
	THD.	0.02	0.019	0.009%			
<b>TRANSIENT INTERMODULATION DISTORTION:</b> Not measurable (3.15kHz square wave and 15kHz sine wave mixed 4:1)							
<b>NOISE &amp; HUM LEVELS:</b> re 1 Watt into 8Ω AUX 82 dB (Lin) 84.5 dB(A) (with volume control set for 1 Watt output with, 90mV input (Aux))							
<b>MAXIMUM OUTPUT POWER AT CLIPPING POINT:</b> (IHF-A-202) (20mS burst repeated at 500ms intervals) (8Ωmms) = 126 V P-P Dynamic Headroom = 248 Watts 0.9 dB (re 201 Watts)							

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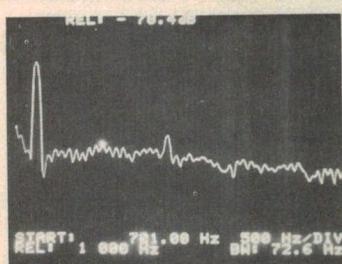
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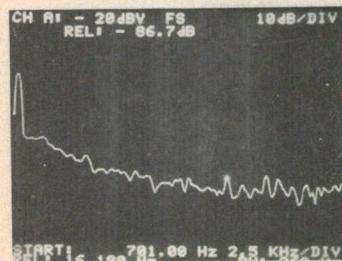


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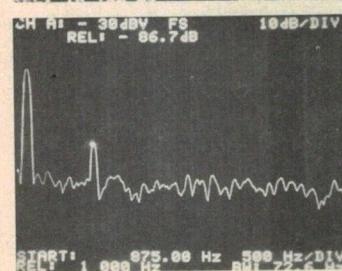
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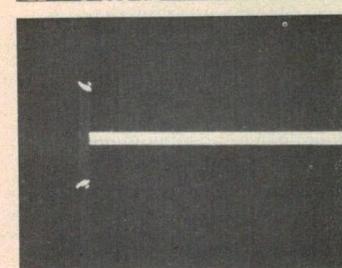
Carver amplifier at 200 watts output; 5 kHz narrow bandwidth analysis of noise and distortion for fundamental 1 kHz signal pre-attenuated by 60 dB. Note that the noise threshold is comparable with the harmonics at -78.4 dB.



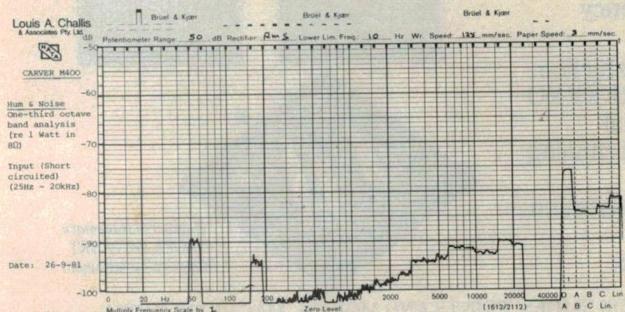
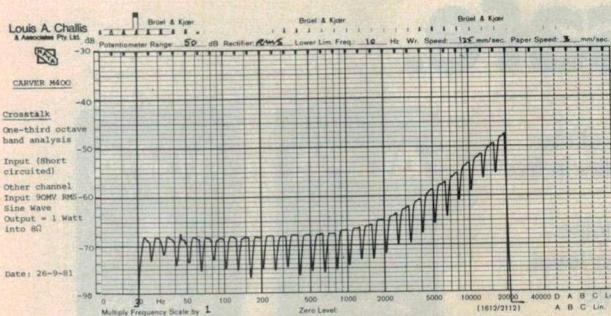
Carver amplifier at 200 watts output; 25 kHz bandwidth analysis of noise & distortion from 1 kHz signal. 1 kHz pre-attenuated by 60 dB. Note the general commutation noise below 17 kHz.

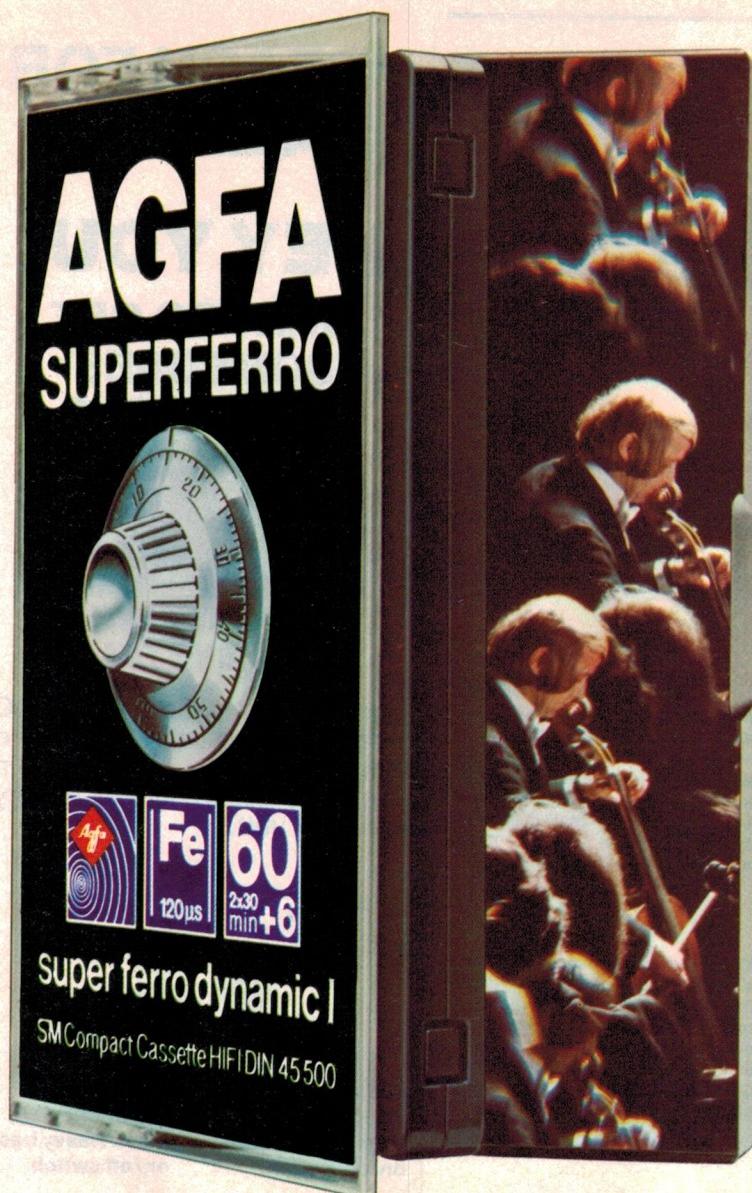


Sansui B77 amplifier at 60 watts (max.) output; 5 kHz narrow bandwidth analysis of distortion of 1 kHz signal pre-attenuated by 60 dB. Note that the third harmonic is -86.7 dB reference the real fundamental and that the noise threshold is at least -15 dB compared to that harmonic.



Measured performance of Carver M400 Magnetic Field Power Amplifier. Transient overload recovery test (IHF-A-202), 50 ms/div. 10 dB overload re rated power into 8 ohms — both channels driven. Overload duration: 20 ms; Repetition rate: 512 ms.



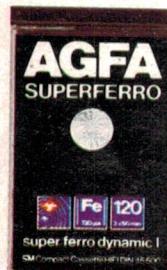


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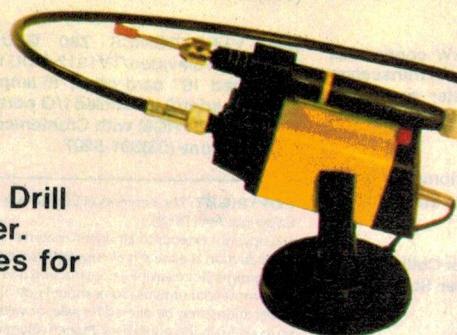
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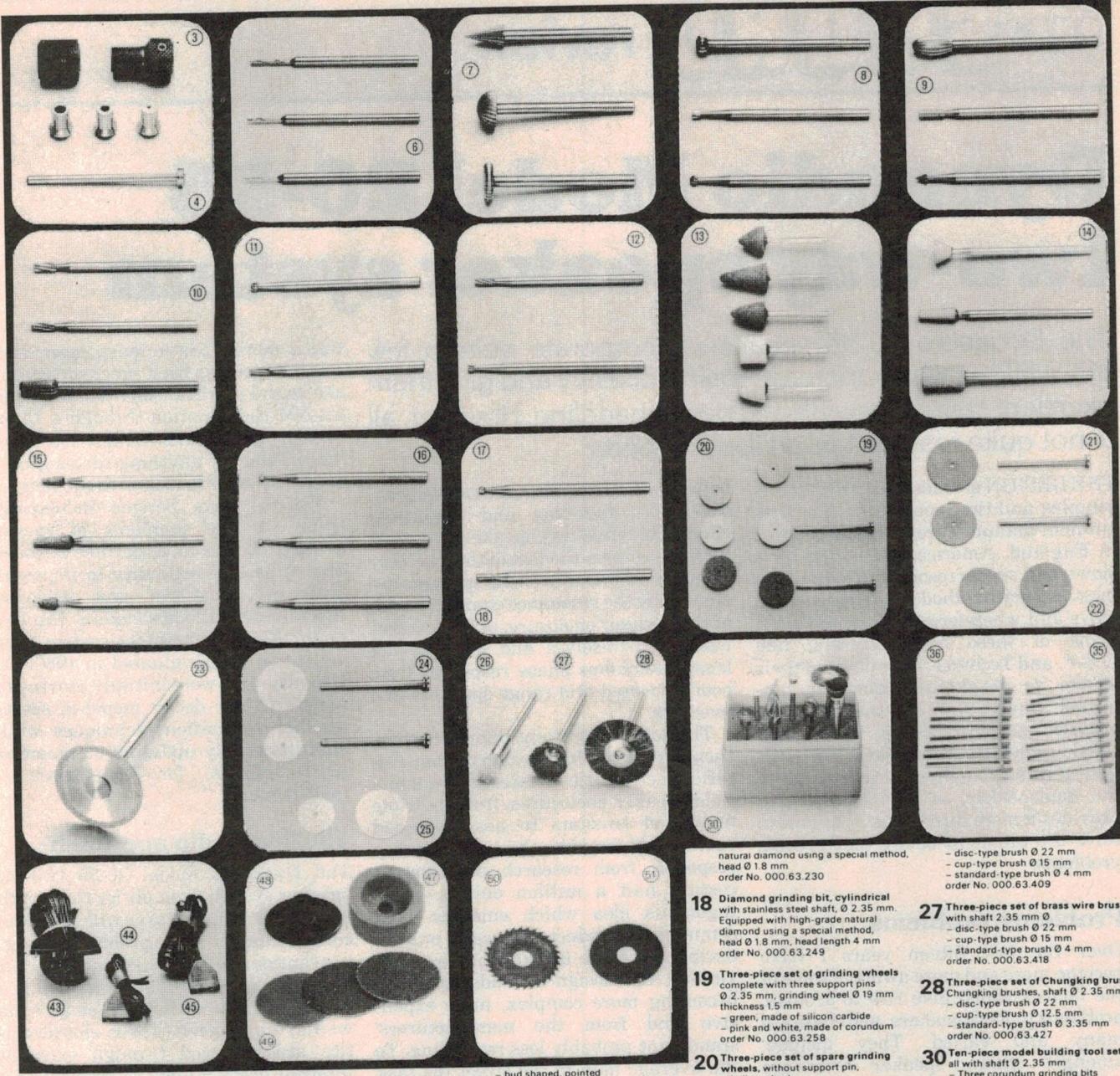
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head Ø 2.3 mm  
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head Ø 2.3 mm,  
head length 2 mm  
- oval, coarse-toothed,  
head Ø 4 mm, head length 2.1 mm  
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head Ø 2.3 mm, head length 6.2 mm  
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- conical, coarse-toothed  
head Ø 2.3 mm, head length 6.4 mm

- bud shaped, coarse-toothed  
head Ø 5 mm, head length 10 mm  
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- circular, coarse-toothed

head Ø 2.3 mm

- conical, coarse-toothed

head Ø 1.8 mm, head length 5 mm  
order No. 000.63.132

Illustration at next page.

**12** Two piece carbide drilling set made of high-performance carbide.

shaft Ø 2.35 mm

- cylindrical, coarse-toothed

head Ø 1.8 mm, head length 5 mm

- conical, coarse-toothed

head Ø 1.8 mm, head length 1.6 mm  
order No. 000.63.141

Illustration at next page.

**13** Five-piece set of grinding bits made of corundum, shaft Ø 3 mm  
- conical with attachments  
head Ø 14.9 mm, head length 15.8 mm  
- conical  
head Ø 13.6 mm, head length 18.1 mm

- bud shaped, pointed  
head Ø 2.5 mm, head length 20.4 mm  
- cylindrical  
head Ø 2.4 mm, head length 13.3 mm  
- bud shaped, blunt  
head Ø 13.2 mm, head length 15 mm  
order No. 000.63.248

**14** Three-piece set of grinding bits

head made of corundum, shaft made of steel, nickel-plated, stainless,

shaft Ø 2.35 mm

- trapezoidal,

head Ø 7.5 mm, head length 5.2 mm

- conical

head Ø 4 mm, head length 10.7 mm

- head Ø 6.4 mm, head length 12.1 mm

order No. 000.63.203

**15** Three-piece glass grinding set for rough grinding of glass. Head made of silicon carbide, shaft made of steel, nickel-plated, stainless, Ø 2.35 mm

- conical, short

head Ø 2.6 mm, head length 6.1 mm

- conical, long

head Ø 3.7 mm, head length 10.8 mm

- bud shaped, pointed

head Ø 3.1 mm, head length 5.8 mm

order No. 000.63.212

**16** Three-piece glass cutting set for cutting contours on glass. Head with natural diamond, shaft made of stainless steel

Ø 2.35 mm, head Ø 1/1, 1/4/1.6 mm

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**17** Diamond grinding bit, circular with high-grade steel shaft, stainless Ø 2.35 mm. Equipped with high-grade

natural diamond using a special method, head Ø 1.8 mm  
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**18** Diamond grinding bit, cylindrical with stainless steel shaft, Ø 2.35 mm.

Equipped with high-grade natural diamond using a special method, head Ø 1.8 mm, head length 4 mm  
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**19** Three-piece set of grinding wheels complete with three support pins Ø 2.35 mm, grinding wheel Ø 19 mm thickness 1.5 mm

- green, made of silicon carbide  
- pink and white, made of corundum  
order No. 000.63.258

**20** Three-piece set of spare grinding

wheels, without support pin, grinding wheel

Ø 19 mm, thickness 1.5 mm

- green, made of silicon carbide

- pink and white, made of corundum  
order No. 000.63.267

**21** Two-piece set of friction discs complete with support pins Ø 2.35 mm, friction discs made of corundum

- Ø 22 mm, 0.6 mm in thickness  
- Ø 25 mm, 1.0 mm in thickness  
order No. 000.63.276

**22** Two-piece set of spare friction discs without support pins, friction discs made of corundum

- Ø 22 mm, 0.6 mm in thickness  
- Ø 25 mm, 1.0 mm in thickness  
order No. 000.63.285

**23** Diamond friction disc with support pin made of stainless steel Ø 2.35 mm.

Equipped with high-grade natural diamond using a special process. Ø 18 mm, 0.7 mm in thickness  
order No. 000.63.294

**24** Two-piece set of circular saw blades complete with support pins made of special stainless steel Ø 2.35 mm,

saw blade Ø 16/22 mm  
order No. 000.63.301

**25** Two-piece set of spare circular saw blades, without support pins, made of special stainless steel, saw blade

Ø 16/22 mm  
order No. 000.63.310

**26** Three-piece set of steel wire brushes with shaft Ø 2.35 mm

- disc-type brush Ø 22 mm  
- cup-type brush Ø 15 mm  
- standard-type brush Ø 4 mm  
order No. 000.63.409

**27** Three-piece set of brass wire brushes with shaft Ø 2.35 mm

- disc-type brush Ø 22 mm  
- cup-type brush Ø 15 mm  
- standard-type brush Ø 4 mm  
order No. 000.63.418

**28** Three-piece set of Chungking brushes

Chungking brushes, shaft Ø 2.35 mm  
- disc-type brush Ø 22 mm  
- cup-type brush Ø 15.25 mm  
- standard-type brush Ø 3.35 mm  
order No. 000.63.427

**29** Ten-piece model building tool set all with shaft Ø 2.35 mm

- Three corundum grinding bits  
- Three milling bits  
- Two brushes, plastic  
- One felt disc on support pin  
- One circular saw on support pin  
order No. 000.62.393

**30** Saw blades for jigsaw, set of ten, coarse

order No. 000.62.117

**31** Saw blades for jigsaw, set of ten, fine

order No. 000.62.144

**43** 3 m extension lead

order No. 000.62.091

- without illustration -

**44** Transformer adapter

order No. 000.62.064

- without illustration -

**45** Car adapter 12 volt

order No. 000.62.073

- without illustration -

**47** Cup grinding wheel made of corundum Ø 32 mm, complete with mount

order No. 000.63.623

**48** Grinding disc, set of three, Ø 40 mm

order No. 000.63.632

**49** Sandpaper, self-adhesive, circular, set of ten. Assorted fine, medium and coarse, Ø 40 mm

order No. 000.63.641

**50** Saw blade for wood Ø 32 mm, complete with mount

order No. 000.63.669

**51** Saw blade for metal Ø 32 mm, complete with mount

order No. 000.63.678

# Dynaudio Model 20-55 two-way speaker system

The Dynaudio 20-55 speakers incorporate quite a few innovations which increase their efficiency and give them excellent stereo imaging and power handling. However, all is not quite rosy, as Louis Challis reports.

THE DESIGN of loudspeaker systems is complex and time-consuming. The pre-eminent manufacturers of loudspeakers in England, America and Japan have slowly but surely resorted to some of the most esoteric methods to determine the whys and wherefores of their products. Some of these manufacturers, like K.E.F. and Technics, have devoted their efforts to developing computer programs which evaluate the transient acoustic performance of their loudspeakers, whilst others like B&W have investigated the physical movement of the loudspeaker, as they believe this provides a more direct clue as to how to solve the problems before they become problems.

## Problems, problems

Over the last fifteen years I have become more and more aware of some of the factors which give rise to acoustic problems in loudspeakers, and these are many and varied. They include, amongst others, speaker resonance problems, break-up of speaker diaphragms, non-uniform vibrational flexure of voice coils, interaction of edge surrounds and flexible surrounds with the radiated sound field, interaction

between the acoustic output of two-way, three-way, four-way and sometimes (God forbid) five-way speaker systems (I hope we've seen the last of those!). Very common problems in cheap speakers are created by the resonance characteristics of the speaker enclosure, of the speaker baskets themselves and last but not least anomalous phase responses from poorly located mid-range speakers and tweeters.

The sorts of solutions offered to solve these problems have ranged from esoteric electrostatic tweeters to concrete field speaker enclosures, from multiple arrays of tweeters to passive-loaded radiators to improve the low frequency response, from research programmes costing half a million dollars to an ingenious idea which emerges as a commercial product one week only to disappear off the market the next. Obviously, the design of loudspeakers is becoming more complex, more expensive and from the manufacturers' standpoint probably less rewarding. To the average man in the street the task of selecting a loudspeaker must be absolutely frightening, for each manufacturer presents claims which are often unsupported and extremely complex to prove or disprove. Even the simple ear

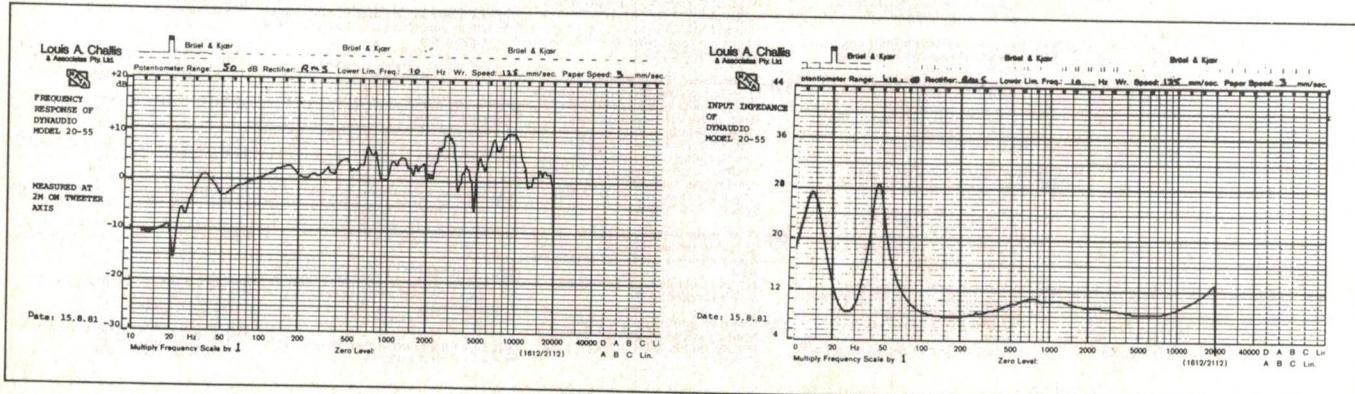
test is no real test in many cases where the listener has been preconditioned to the sound of a transistor radio playing an AM radio station through a 75 mm (3 inch) loudspeaker. After that sort of 'hors d'oeuvre' anything tastes good — even a speaker loaded with problems.

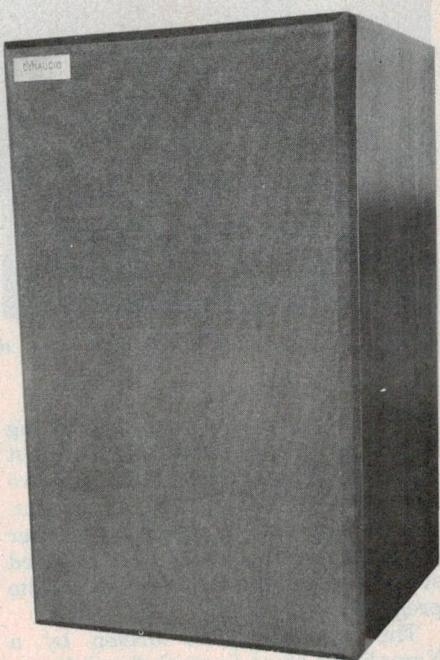
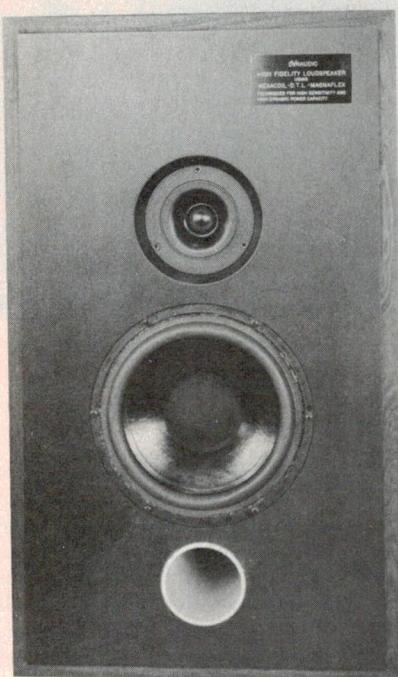
We too have become increasingly aware of the problems of speaker evaluation and have devoted considerable time and ingenuity to improving both our objective and subjective assessments of loudspeakers. The Dynaudio 20-55 loudspeaker system is one which we first evaluated in 1980, at a time when we were initially proving the merits of our decay response spectra speaker evaluation techniques whilst simultaneously updating our monitoring facilities for comparison of loudspeakers.

## The Dynaudio approach

The Dynaudio Model 20-55 two-way speaker system exemplifies the lengths to which a manufacturer will go to overcome a number of the problems facing a conventional loudspeaker system. The enclosure is remarkably solid and is as free of cabinet resonances as any that we have ever seen. These characteristics are achieved through extensive internal bracing and the application of composite materials which provide high damping concurrent with high mass.

The main driver, a Model 21W-54 speaker with a 220 mm diameter cone, incorporates a patented hexacoil wire





voice coil for which the manufacturers claim a 30% increase in efficiency and in the force factor over that provided by a comparable conventional circular wire voice coil. Obviously, with such improvements in efficiency one would expect high output and reasonable sensitivity, and subsequent testing showed this to be the case.

The tweeter is a model D28 soft-domed speaker with a 28 mm diameter diaphragm which incorporates a magnetic fluid between the voice coil and the magnet assembly to enhance voice coil damping and simultaneously improve transient response. This approach may or may not achieve enhancement of transient performance, depending on the design of the tweeter itself, but the addition of the magnetic fluid un-

questionably improves the thermal dissipation capabilities and thus the ability to handle high-level signals without destroying the speaker. All the drivers are of Danish manufacture.

The enclosure incorporates oak veneered particle board side panels with a well-designed open weave brown grille cloth retained by means of Velcro-type fasteners. The woofer incorporates a wide EPDM rubber surround to provide the long throw travel the diaphragm needs to achieve, whilst the tweeter is recessed well back behind the front panel to meet the phase requirements of a linear phase system. The rear of the cabinet features a Bulgin-type speaker socket, for which a mating plug and two metre long lead are also provided.

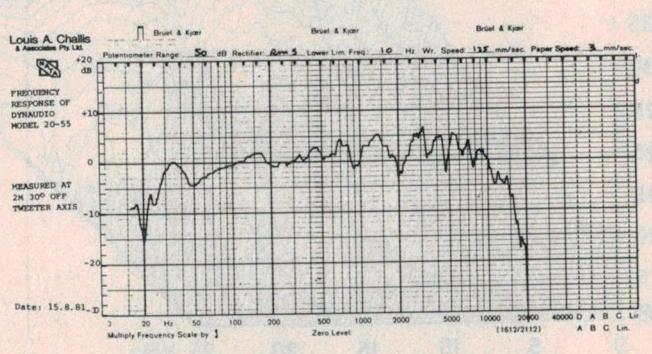
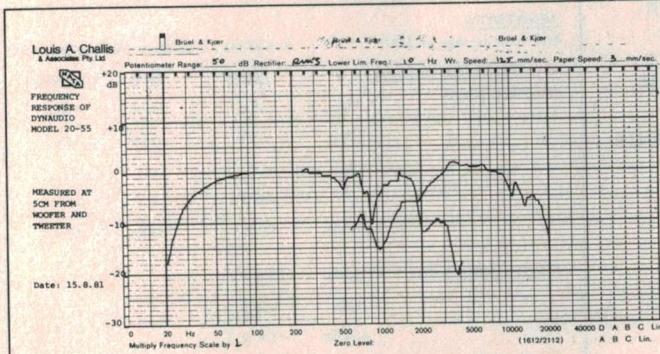
## On test

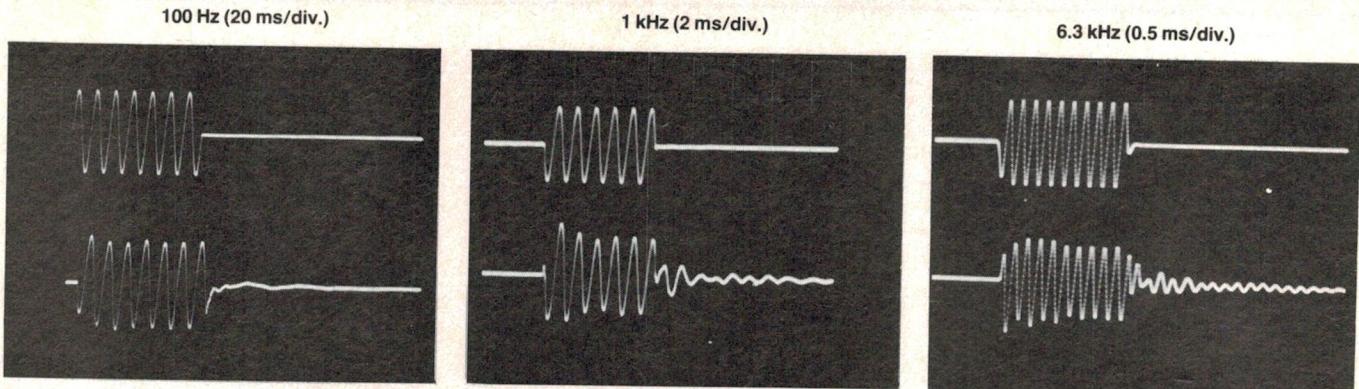
The frequency response of this speaker system extends from 35 Hz to beyond 20 kHz, with some unusual peaks and ripples occurring in the frequency domain of the tweeter. The low frequency response is dominated primarily by the interaction between the loading port vent and the woofer, which are placed closer together than in most other speaker systems of this type. The speaker resonance occurs at 45 Hz, with an unusual subresonance occurring at 14 Hz. It is apparent from a comparison of the near field frequency response with the response at 2 m that a different location for the loading port would most probably improve the low frequency linearity.

The impedance curve is remarkably close to an optimum 8 ohm impedance and as such the speaker could readily be paralleled with other 8 ohm speakers without creating problems.

The tweeter response is not nearly as smooth as we would like and this comes primarily as a result of the design of the tweeter, which our measurements indicate falls short of the sort of performance that the best tweeters are capable of providing. In particular, the drooping characteristic above 10 kHz is regrettable and this is compounded by what appear to be reflections from the recessed face of the enclosure. These do not show up in the near field response but do in the far field response.

The phase response of the speaker is generally smooth and quite good, but even here minor reflections from the recessed face show up in terms of a small ripple. The distortion characteristics of the speaker are particularly good, and even the distortion level at 100 Hz when producing 90 dB at two metres is very low at only 0.9%.





Tone burst response of Dynaudio Model 20-55 (for 90 dB steady-state SPL at 2 m on axis). Upper trace is electrical input; lower trace is loudspeaker output.

By and large the speaker has obviously been designed to deliver high outputs with generally low distortion, and subsequent testing confirmed this. The decay response spectrum of the speaker exhibits similar non-uniformity to that determined by us a year ago, and this non-uniformity is directly attributable to the tweeter; we believe this could be improved by a change of physical characteristics of the soft dome, which must be generating its own resonant characteristics, particularly in the vicinity of 2 kHz and also in the 10 kHz region.

### To the ear

The subjective testing of the speaker was more rewarding on this occasion than it was a year ago, and the Dynaudio speakers proved to have exceptional power handling capabilities, with the ability to produce sound pressure levels in excess of 105 decibels at 4 m distance in our monitoring room. Under these con-

ditions, peak power levels approaching 300 watts were accepted without significant complaint, but positive colouration of the sound was evident, particularly on trumpets and other wind instruments, which demonstrated strident characteristics atypical of the programme content.

The speakers were driven by a Yamaha B4 amplifier with the ability to provide 350 watt peak signals, and the speakers did not miss a beat. When playing violins, organs, pianos and guitars the colouration was not particularly pronounced and the sound was, with this type of programme content, very similar to the monitors. When playing Tedare's Moussorgsky's 'Pictures At An Exhibition' (10042) and a Nakamichi Digital Mastering Direct Cassette 'Jazz Fusion Studio Live' (DM001) the speakers provided a generally good performance, only marred by colouration in the 2 kHz region, primarily on woodwinds, trumpets and trombones.

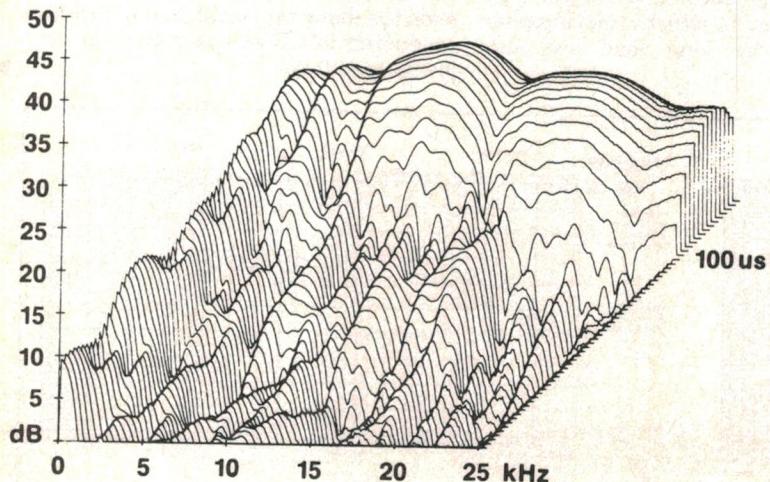
### Summary

The Dynaudio speakers provide excellent stereo imaging, power handling capacity and particularly low distortion. Given that their selling price is close to \$1500, it would be a shame if the manufacturers did not spend a little extra time in minimising the decay resonance characteristics of the tweeter to achieve a performance which is already so close to their design aims. ●

#### DYNAUDIO 20-55 LOUDSPEAKERS

**Dimensions:** 675 mm high x 396 mm wide x 400 mm deep  
**Weight:** 31 kg  
**Price:** About \$1500  
**Manufactured by:** Dynaudio Australia Pty Ltd.  
**Distributor:** Dynaudio Australia Pty Ltd, P.O. Box 2, Hawthorn Vic. 3122.

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MEASURED PERFORMANCE OF DYN AUDIO MODEL 20-55			
<u>FREQUENCY RESPONSE:</u>			30Hz-20kHz
<u>CROSSOVER FREQUENCIES:</u>			1800Hz
<u>SENSITIVITY:</u>			
(for 90dB average at 2m)	10.5 VRMS = 13.8 Watts (nominal into 8Ω)		
<u>HARMONIC DISTORTION:</u>			
(for 90dB at 2m)	100Hz	1kHz	6.3kHz
2nd	-44.3	-49.1	-40.8
3rd	-43.6	-54.9	-53.5
4th	-	-	-
5th	-58.1	-	-
T.H.D.	0.9%	0.4%	0.94%
<u>INPUT IMPEDANCE:</u>			
100Hz	8.6 Ω		
1kHz	10.4Ω		
6.3kHz	8.4 Ω		
Minimum at	170Hz	7.8 Ω	



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OUR 'QUOTES' competition in the July issue attracted some thoughtful entries. Most seemed to have been assisted by the Oxford Dictionary of Quotations, but that is not necessarily the primary source, so there were some interesting differences between entries as well as our quotes. Here are the correct versions and their origins (and no correspondence will be entered into ...):

### 1. Elementary, my dear Watson.

This is a strange misquotation. The closest to it is "Excellent!" (Dr. Watson) cried. "Elementary," said he (Holmes). Sir Arthur Conan Doyle, from 'The Crooked Man' in 'The Memoirs of Sherlock Holmes'.

### 2. We are the masters now.

The quote we had in mind was "We (Labour) are the masters at the moment — and not only for the moment but for a very long time to come". Sir Hartley Shawcross in the House of Commons, April 1946.

### 3. Come up and see me sometime.

The correct version is "Why don't you come up sometime and see me," said by Mae West in the movie 'She Done Him Wrong' — an adaptation of 'Diamond Lil'.

### 4. Money is the root of all evil.

Correct version is: "The love of money is the root of all evil", 1 Timothy v. 10.

### 5. I knew him well, Horatio.

This should be "Alas! poor Yorick. I knew him, Horatio". Spoken by Hamlet in Hamlet, Prince of Denmark, Act V Scene 1, by William Shakespeare. (We know most people give the famous Bard an 'e' on his name, but our Managing Editor main-

tains that it was never spelt that way in Shakespear(e)'s time, and who are we to argue?)

### 6. Survival of the fittest.

"This survival of the fittest", from Herbert Spencer's 'Principles of Biology' (1865). Spencer was referring to the "fittest" in the sense of the **most suitable** — not the most fit physically.

### 7. I want to be alone.

We can do no better than to reprint the winning entrant's answer: "I want to be alone" is from the movie 'Grand Hotel' (1932) from a script by W.A. Drake; the words are said by Greta Garbo. However, the phrase had frequently been attributed to Greta Garbo before being used in the film; she appears in fact to have said on various occasions (off-screen) "I want to be left alone" and "why don't they leave me alone."

### 8. The stuff that dreams are made of.

Should be:

"We are such stuff  
As dreams are made on".

From 'The Tempest', Act IV, by W. Shakespeare.

### 9. To gild the lily.

Correct version is "To gild refined gold, to paint the lily..." Spoken by Salisbury in 'King John', Act IV, Sc. II, by W. Shakespeare.

### 10. I must go down to the seas again.

Most entrants said that the quote was correct as printed. Not so. It's from Masefield's 'Sea Fever' and should read "I must down to the seas again" (there's no "go").

### 11. First catch your hare.

Not Mrs. Beeton but Hannah Glasse in the 'Art of Cookery' (1747). It reads "Take your hare when it is cased".

### 12. Lead on, Macduff.

Correct version is "Lay on, Macduff. And damn'd be him that first cries, 'Hold, enough!', from Macbeth, Act V, Sc. vii. W. Shakespeare.

### 13. Pride goeth before a fall.

From Proverbs xvi, 18. "Pride goeth before destruction and an haughty spirit before a fall".

### 14. All that glitters is not gold.

There are several versions that could be taken as originally correct. However, we feel the closest is "All that glitters is not gold" from 'The Merchant of Venice', Act II, Sc. vii. I'm indebted to several readers who quoted from Thomas Gray's poem 'Ode on the Death of a Favourite Cat': "Nor all that glitters, gold".

### 15. Thou shalt not kill — but needst not strive officiously to stay alive.

This is another curious one. The correct version is "Thou shalt not kill — but needst not strive officiously to **keep** alive", and it's from Arthur Hugh Clough's 'The Latest Decalogue', which is an ironical version of the Ten Commandments. It was not in any way at all intended as advice to doctors — but is often taken as such now.

Two entries from the Cerini household of Kilmore East in Victoria had the least errors; they had answers to misquotes 8 and 11 incorrect, so we've arranged a special prize for Messrs J. and M. Cerini. Congratulations!

Curiously, second place was a tie between K. Mitchell of Seven Hills in NSW and Laurence Blake (just 15 years old!) of Lower Plenty in Victoria. Congratulations one and all! Thank you to all those who entered, don't miss our next exciting Dregs competition ...

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